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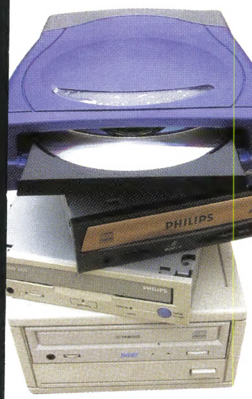

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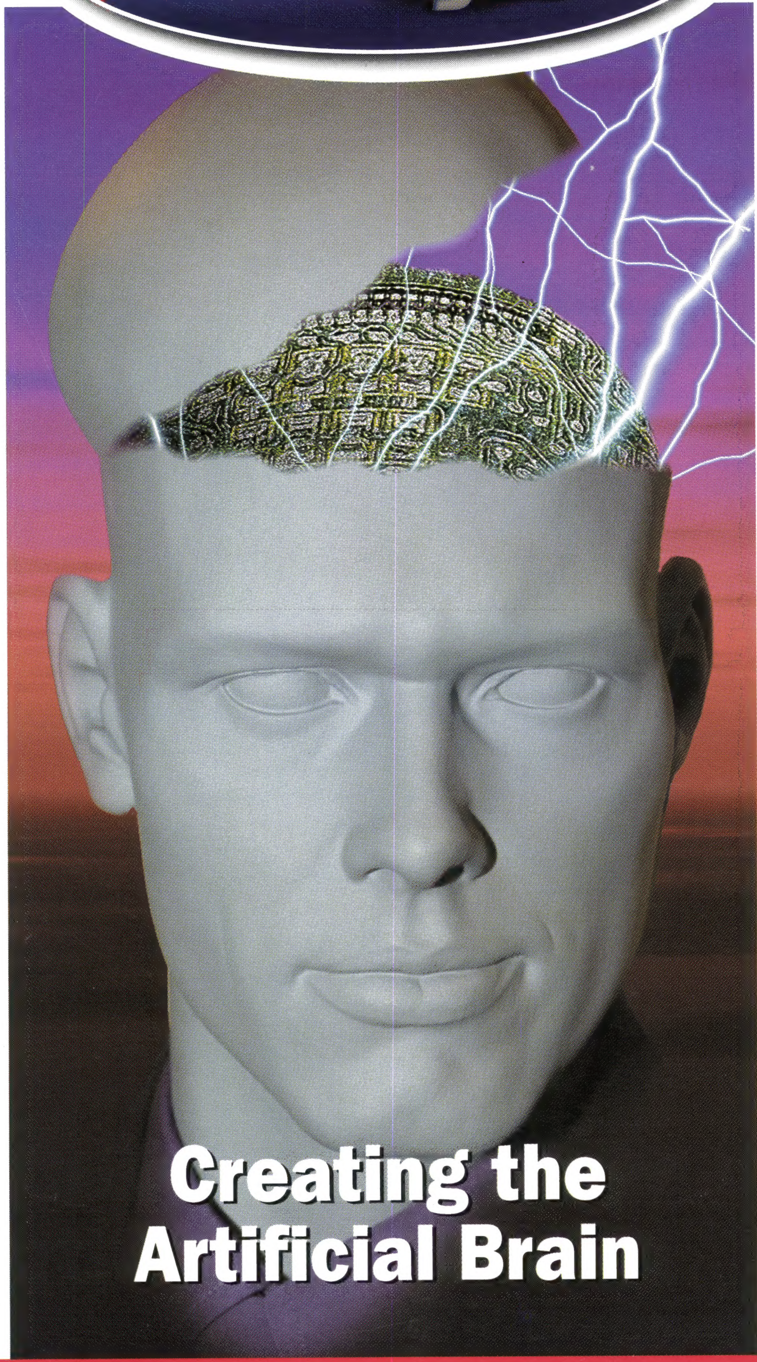

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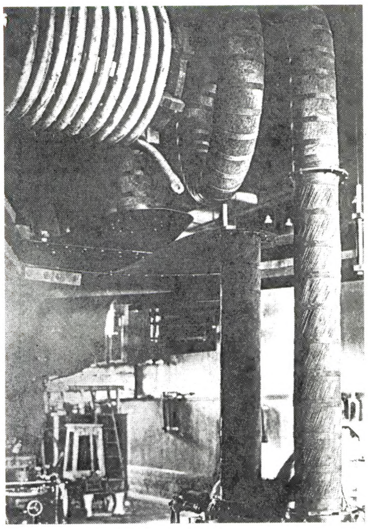

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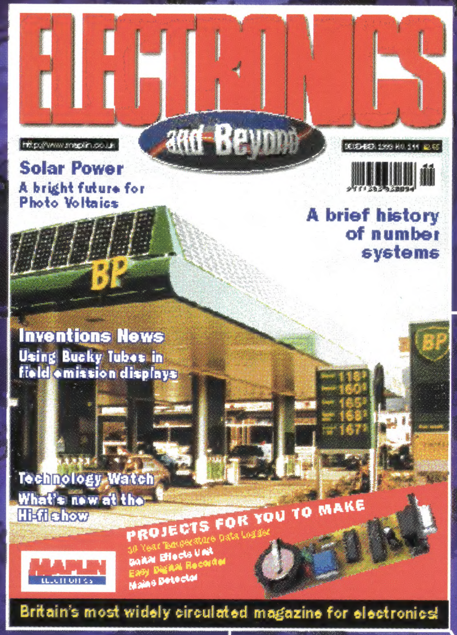
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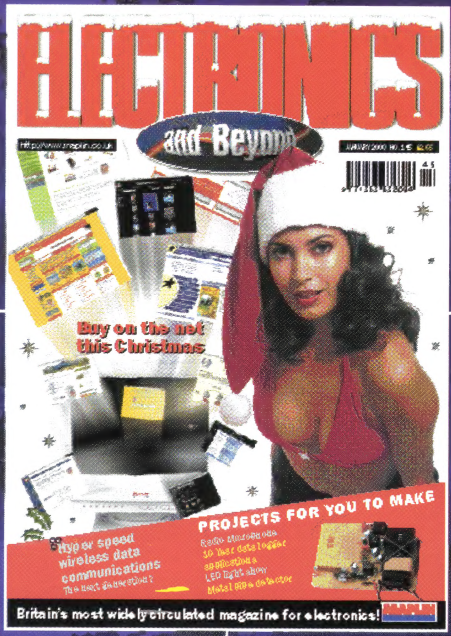
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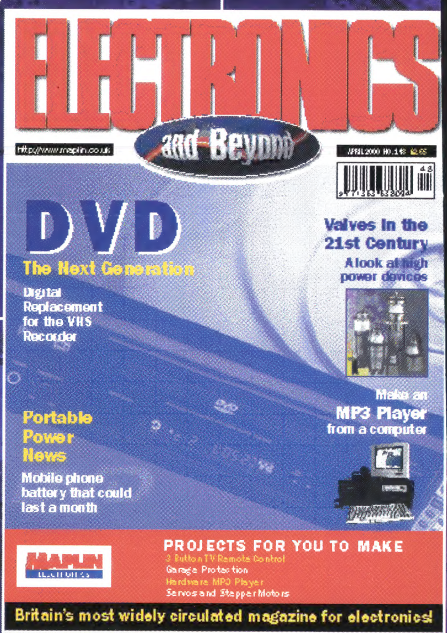
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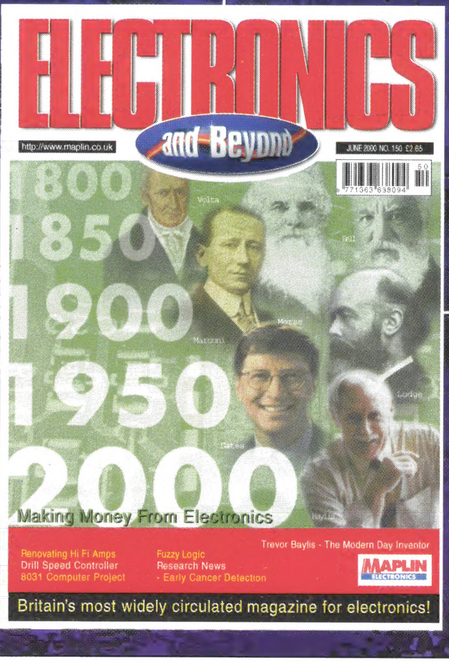

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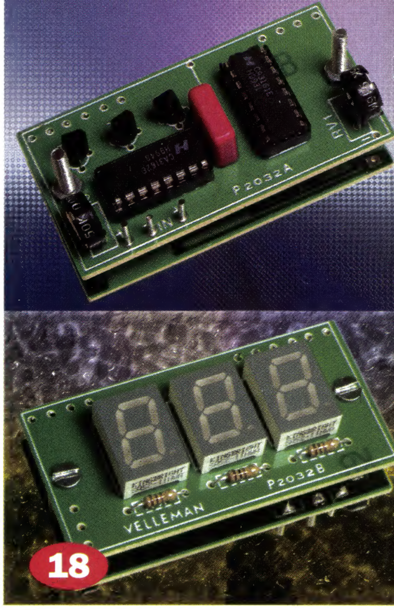


18

Projects

8 **PC Controlled Disco Lights**
Rob Heslop describes a simple-to-build disco light system for all budding DJs.

18 **Digital Panel Meter**
John Mosely constructs this versatile, easy-to-build kit from Velleman.

49 **General Purpose Portable Alarm**
Gavin Cheeseman describes a simple, low-cost, versatile alarm.

60 **MP3 Player Update - Part 2**
Martin Pipe completes the revision of his PC-based MP3 player project.

Features

7 **Uri Geller Extended Reality**
Uri reports on how a lone North Pole walker is attempting to communicate with colleagues using telepathy.

14 **Research News - Liquid Crystal Displays**
In this final part, Dr. Chris Lavers looks at the latest LCD technology and what we can expect in the future.

20 **Easy Web Page Creation - Further Reading**
Mike Holmes brings his recent series on Web page design up to date, and looks at dynamic documents, scripts and applets, page scripting and much more.

24 **The Very Long Waves.**
In the penultimate part, George Pickworth looks at the high power spark and arc transmitters of the early 20th Century.

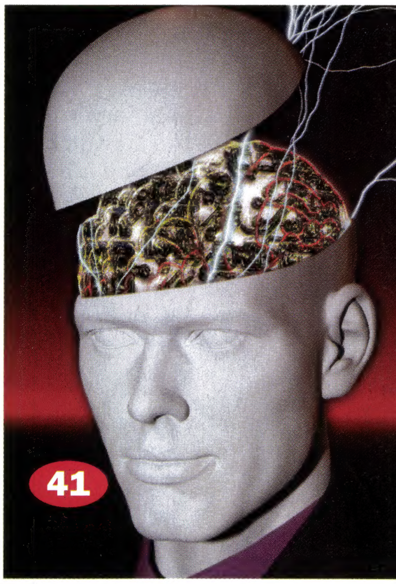
41 **The Artificial Brain**
David Clark discusses how the latest artificial intelligence systems mimic the behaviour and structure of the human brain, and looks at the principles behind the 'artificial brain'.

46 **Towards a Safer Future**
Douglas Clarkson attempts to assess how a developing Internet age will change the perception of risk in society and he highlights some ways to minimise the risk to the individual.

53 **Mastering Audio**
The CD-R(W) drive is undoubtedly one of the most useful peripherals available, not least because they allow you to make your own audio CDs! Martin Pipe examines how you can get the best results.

65 **Beyond the Silicon Microprocessor**
Mike Bedford concludes his look at the future replacement for silicon in the electronics industry.

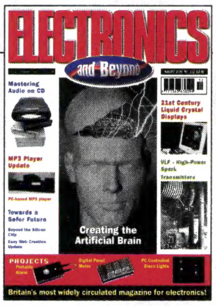
49



41

Regulars

2 **News Report**
13 **Software Hints & Tips**
33 **@ Internet**
59 **Comment**
70 **What's On & Diary Dates**
72 **In The Pipeline**
IBC **Subscribers' Offers**



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53

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ELECTRONICS and Beyond

The theme this month is very much entertainment. Martin Pipe continues with an update to his MP3 player featured in our March and April issues, with further ideas on burning audio CDs in his other article Mastering Audio.

These two articles are very much related. And in a similar way so is the simple PC controlled disco lights system from Rob Heslop, which is yet another indication of how audio entertainment is moving to a totally digital world.

Intelligent systems, machines and robots, are now practical realities. Artificial intelligence is already widely used in software fields as diverse as disease diagnosis, financial market modelling, project planning, speech recognition etc. And for hardware applications the inputs of FPGAs can be connected to sensors and the outputs to motors, actuators etc. In his thought-provoking article, The Artificial Brain, David Clark discusses how the latest artificial intelligence systems mimic the behaviour and structure of the human brain, and looks at the principles behind the 'artificial brain'.

As the Internet age develops, it will be most interesting to observe how it changes the perception of risk in society, and more importantly perhaps how it is used to minimise the risk to the individual from all the processes that will constitute life in the 21st century. Douglas Clarkson in his article Towards a Safer Future looks at the problem of risk assessment and the ways and means of reducing the risk to our ourselves, whether it be from the food we eat to driving on our roads.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Lego Partners with Spielberg to Inspire Young Movie-Makers

Lego has formed an alliance with filmmaker Steven Spielberg to launch Lego Studios, a new product that allows kids to create real movies.

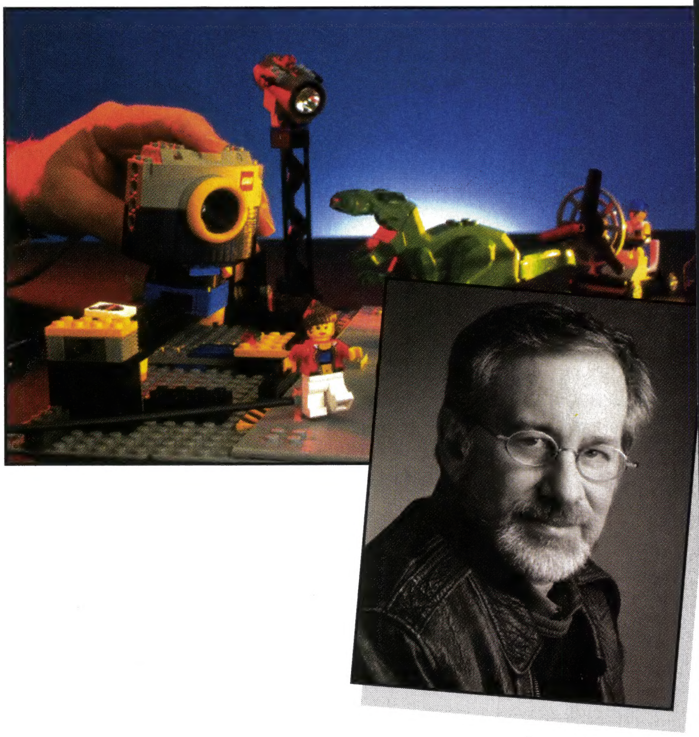
Scheduled to be on store shelves early next year, Lego Studios enables children ages 8 to 16 to bring the imaginative adventures in their Lego worlds to life.

The set includes a PC movie camera, editing software and an assortment of Lego props and unique elements. Also included is a book of tips, tricks and challenges for making real movies.

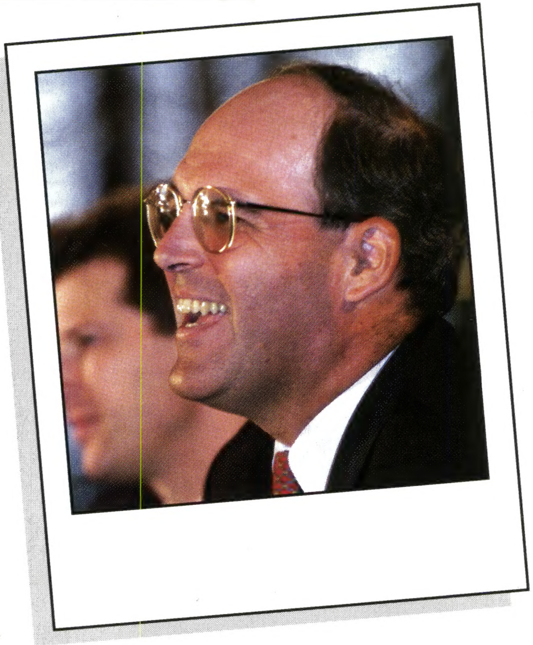
Youngsters first build their story and capture the action on the PC movie camera. They then use the child-friendly editing software with professional functionality to edi their footage, and add music and sound effects.

For further details, check: `<www.lego.com/studios>`.

Contact: Lego,
Tel: (01753) 495000.



Compaq Attacks High-End Server Market



Compaq has announced an ggressive attack on the £20 billion high-end UNIX market with the worldwide launch of its new AlphaServer GS Series systems.

Targeting dot-coms as well as customers in telecommunications, high- performance technical computing, healthcare and financial services, the new AlphaServers are optimised to support the most demanding e-business applications and customer environments.

For further details, check: **<www.compaq.com>**.

Check: Compaq,

Tel: (0845) 270 4000.

WAP's Window of Opportunity Closing

WAP's window of opportunity is closing, warns analyst Ovum As the first generation of WAP-enabled mobile phones finally comes to market, the industry has been warned: you don't have long to get this right.

In a report released in May, ndependent research and consulting company Ovum tells players intending to jump on the WAP bandwagon that WAP isn't the only technology available.

Now that users are beginning to see what all the fuss over WAP was about, there is a significant danger of disappointment and backlash against the technology.

As Ovum's report points out, the development of WAP was never going to be easy given the widely differing interests of the players involved - what Ovum calls a collision of the mobile world with the Internet world.

This has resulted in slow progress and disappointing early releases of the technology. In fact, WAP may end up being squeezed as next-generation technologies based on XML catch up during the next three years.

In the meantime, although WAP has massive industry backing, the delays in decision-making are leading some players to hedge their bets.

Ericsson, for example, is backing a dual-mode microbrowser. Even worse, the development of WAP handsets has been out of step with coming 2G+ mobile network upgrades.

This means that the early WAP user will need to buy yet another handset to take advantage of the faster speeds.

For further details, check: **<www.ovum.com >**.

Contact: Ovum,

Tel: (020) 7551 9021.

Industry Luminary Predicts Technology Futures

In 1991 he asserted, "Microsoft is abusing its monopoly", called for greater encryption on the Internet in 1996, and recently said that Linux would fizzle against Windows.

Now, renowned computer industry renaissance man, Bob Metcalfe has combined some of his most memorable InfoWorld columns along with frank rebuttals from a who's-who of computing luminaries in his new book 'Internet Collapses And Other InfoWorld Punditry' published by IDG Books Worldwide.

Since 1992 Metcalfe, the creator of Ethernet and founder of 3Com, has inspired and challenged his readers and the world's leading technologists with his thought-provoking columns and predictions at **<www.infoworld.com>**. This collection is no exception.

Ranging from comments on renaming cyberspace to questioning the legality of Microsoft's business practices, these columns speak to the state of our technological culture. Metcalfe's columns such as "The Oh-So-Slow Internet," "Wireless Computing Will Flop... Or Will It?," "Making ISPs Accountable," "Crypto, Privacy and Censorship," "The Telco Empire Strikes back," "The Day The Internet Stock Bubble Bursts" will engage and amuse readers.

Each guest rebuttal and commentary is a no-holds-barred comment on Metcalfe's assertions and opinions. Nobel Prize winner Arno Penzias, Open Source evangelist Eric Ray, Internet Pioneer Vint Cerf and many others take aim at Metcalfe's opinions with surprising candor and intensity.

For further details, check: **<www.idgbooks.com>**.

Contact: IDG Books,

Tel: +1 800 434 3422.

NEWS BYTES

TI Notches up a Million Digital Processors

Texas Instruments (TI) has sold its one millionth digital signal processor (DSP) device after only nine months of production, making it one of the most rapidly accepted general-purpose DSPs in the industry.

DSP works by clarifying, or standardising, the levels or states of a digital signal. A DSP circuit is able to differentiate between human-made signals, which are orderly, and noise, which is inherently chaotic

Hundreds of customers and thousands of developers are currently using or have design-ins with the TI C5402 DSP product across a wide range of portable, wireless, networking, industrial and telecom applications.

For further details, check: **<www.ti.com>**.

Contact: Texas Instruments, Tel: (1604) 663399.

Government Gives Consent for Cheshire Power Station

Energy Minister Helen Liddell has given the go ahead to ICI Chemicals & Polymers to build a 250MW gas-fired combined heat and power station at Runcorn, Cheshire.

Combined heat and power plants are designed to produce both electricity and usable heat. They have environmental benefits due to their very high levels of efficiency.

The proposed station will supply the heat and electricity needs of the ICI Chlor-Chemicals Runcorn works.

For further details, check: **<www.dti.gov.uk>**.

Contact: DTI, Tel: (020) 7215 5000.

IBM Backs Linux for Server Solution

IBM has announced Linux software and services for the S/390 enterprise server. The announcement is the latest initiative in IBM's strategy to support Linux across its portfolio of e-business servers and services.

For further details, check: **<www.s390.ibm.com>**.

Contact: IBM, Tel: (020) 8818 4000.

NEWS BYTES

Dolby and ARM Enter Patent Agreement

To cut costs, save time, and better Dolby Laboratories has entered into an agreement with ARM, allowing it to develop an optimised version of Advanced Audio Coding (AAC) technology for the ARM architecture.

The ARM-optimised AAC implementation, available now through ARM, enables hardware manufacturers to create ARM Powered™ portable music playback devices capable of decoding high-quality music delivered via the Internet.

AAC is the latest audio coder standardised by the International Organisation for Standardisation (ISO) as part of the MPEG specification.

Compared to MPEG Layer-3, popularly known as MP3, AAC provides higher quality music while requiring approximately 30% less storage and/or bandwidth.

For further details, check: **<www.arm.com>**.

Contact: ARM,
Tel: (01223) 400400.

High-Tech Industry Leaders Announce Open Internet Exchange

Twelve high-tech industry leaders have announced their intent to launch an independent company that will operate an open Internet exchange to serve the needs of the high-tech supply-chain community.

The 12 companies are: AMD, Compaq, Gateway, Hitachi, Hewlett-Packard, Infineon, NEC, Quantum, Samsung, SCI Systems, Solectron and Western Digital.

The new venture will provide services to buyers and sellers involved in computing and electronics-related industries. The exchange is expected to enable these businesses to manage their supply chains more efficiently and effectively, improve delivery of products and services to the marketplace, and increase customer satisfaction.

An estimated £370 billion in online business-to-business sales of high-tech components and parts will occur over the next few years, making this the world's largest e-marketplace opportunity.

The founding companies are some of the world's largest buyers and suppliers of computer and electronics components and products and have developed considerable expertise in efficient procurement and sales.

For further details, check: **<www.hp.com>**.

Contact: Hewlett-Packard,
Tel: (01344) 773100.

1... Limited Consortium Gains European Union Award

A multinational consortium of seven partners, led by 1... Limited the Cambridge-based digital loudspeaker company, has been awarded a total of £1.3 million, under the European Commission's Framework Five programme, to develop high performance piezoelectric array devices for digital loudspeakers and steered array antennas.

The seven partners are: 1... Limited (Cambridge, UK) which acts as Scientific and Technical Coordinator, University of Birmingham (UK) also acting as Finance & Administrative Coordinator, Haikutech Holding B.V. (Reijmerstok, The Netherlands), Marconi Caswell Limited (Caswell, UK), ESPCI Laboratoire Onde et Acoustique (Paris, France), UMIST (Manchester, UK), and University of Erlangen-Nuremberg (Germany).

The principal areas of investigation are high performance, large-excursion piezoelectric-ceramic linear transducers for acoustic and phase-shifting functions, contr electronics for transducer driving, and aerogel sound absorber development.

For further details, check: **<www.uno.to>**.

Contact: 1... Limited,
Tel: (01223) 422290.

NASA Plans Next Giant Leap for Mankind

NASA's Marshall Space Flight Centre in the US is developing space sails technology to power a mission beyond our solar system.

The interstellar probe will travel over 23 billion miles - 250 astronomical units - beyond the edge of the solar system. The distance from Earth to the Sun, 93 million miles, is one astronomical unit.

For perspective, if the distance from Earth to the Sun equalled one foot, Earth would be a mere 6 inches from Mars, 38 feet from Pluto, 250 feet from the boundaries of the solar system, and a colossal 51 miles from the nearest star system, Alpha Centauri.

This first step beyond our solar system en route to the stars has an estimated trip time of 15 years. Proposed for launch in a 2010 time frame, an interstellar probe - or precursor mission, as it's often called - will be powered by the fastest spacecraft ever flown.

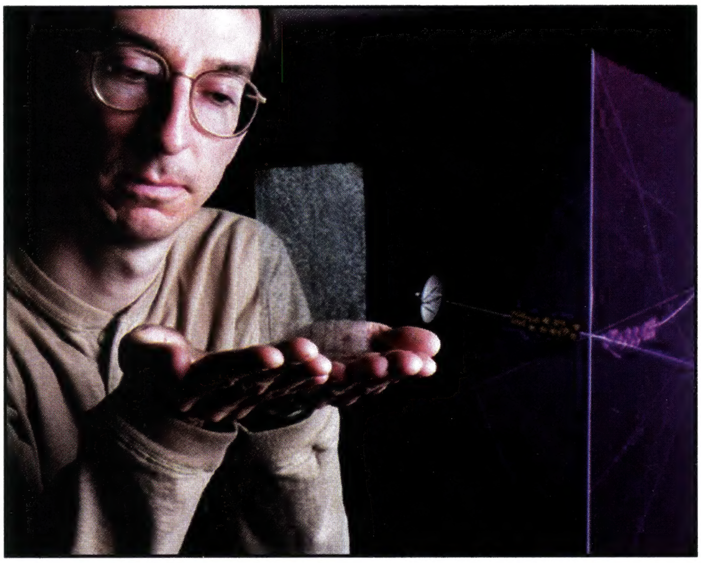
Zooming toward the stars at 58 miles per second, it will cover the distance from New York to Los Angeles in less than a minute.

It's more than 10 times faster than the Space Shuttle's in-orbit speed of 5 miles per second. Travelling five times faster than Voyager - a spacecraft launched in 1977 to explore our solar system's outer limits - an interstellar probe launched in 2010 would pass Voyager in 2018, going as far in eight years as Voyager will have journeyed in 41 years.

Thin, reflective sails could be propelled through space by sunlight, microwave beams or laser beams - just as the wind pushes sailboats on Earth. Rays of light from the Sun would provide tremendous momentum to the gigantic structure.

For further details, check: **<www.nasa.gov>**.

Contact: NASA,
Tel: +1 256 544 2121.



Abilitynet Widens Disabled Access

People with disabilities will be able to learn using new technologies more easily, thanks to the appointment of charity AbilityNet to provide support to the Department for Education and Employment (DEE) in the initial phase of its £252 million ICT (Information and Communication Technologies Learning Centres initiative.

ICT Learning Centres aim to give adults who have little or no access to new technologies, the opportunity to learn computer and other ICT skills.

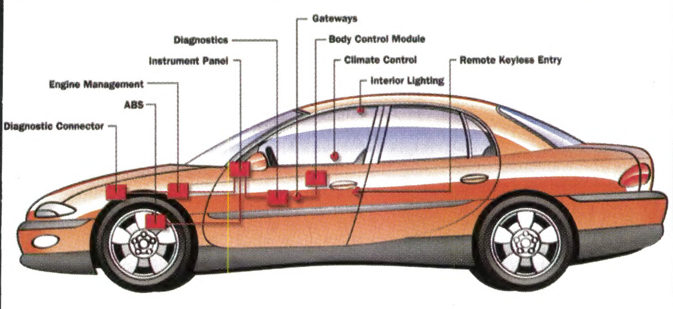
Around 700 ICT Learning Centres will be set up in local communities across England from September 2000, to suit local needs and current provision. A range of early projects, including 13 Pathfinder centres, are currently testing out approaches to setting up and managing ICT Learning Centres.

AbilityNet is providing staff and disabled clients of these early 'Pathfinder' learning centres with specialist hardware and software for the adaptation of PCs, plus training, advice, telephone and Web site backup. The lessons learned here will help to inform the development of provision for staff and disabled clients in ICT Learning Centres over the next two years.

For further details, check: **<www.abilitynet.co.uk>**.

Contact: AbilityNet,
Tel: (0800) 269545.

hips with Everything



Flash microcontrollers allow consumers to update their automobiles and appliances with enhanced performance and functionality through Internet connectivity. Using a simple telephone connection at the dealership, electronic subsystems within a typical car can be reprogrammed throughout the vehicle's service life.

new wave of electronics telligence is bringing Internet onnectivity to hundreds of ousehold appliances thanks to xploding demand for flash-emory microcontrollers.

The average household lready owns more than 150 icrocontrollers, the ubiquitous w-cost chips that provide lectronics intelligence to housands of applications, such s dishwashers, garage door peners, remote controls, and otorcars.

By incorporating flash program memory on the chip, the microcontroller has the ability to reprogram itself, allowing consumers to upgrade these appliances with new features and functionality.

This can be accomplished in the home or anywhere by downloading software via the Internet through a telephone line into the appliance

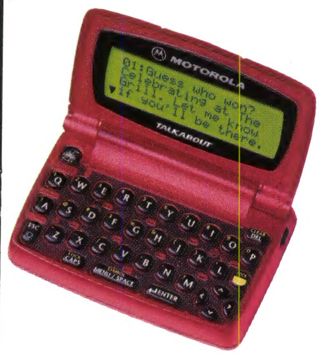
In order to stay ahead of the strong demand for flash microcontrollers, Microchip Technology announces it is quadrupling its flash microcontroller portfolio.

Using the performance of flash microcontrollers, many consumer appliances can be upgraded with additional capability.

For example when a vehicle is brought in for service, the technician may be required to upgrade the body control module. Typically the body control module is removed and replaced with a newer version. This increases cost on the service.

But by utilising an under-bonnet connector and readily available tools on hand at the dealerships, the new software can be 'downloaded' through the under-bonnet connector and into the flash memory in a very controlled environment For further details, check: **<www.microchip.com>**. Check: Microchip, Tel: (0118) 921 5800.

Motorola Launches nteractive Communicator



The Talkabout T900 is a personal interactive communicator from Motorola, that incorporates low-cost two-way wireless messaging capabilities.

The compact, keyboard-based device enables users to send and receive text messages and Internet e-mail - as well as request up-to-date information from the Web.

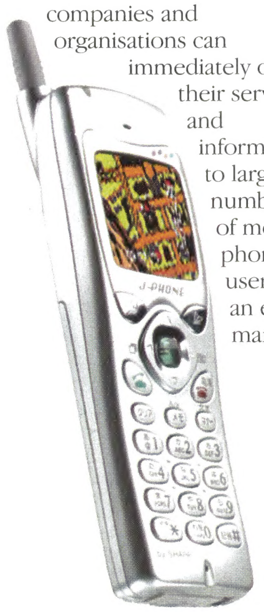
For further details, check: **<www.motorola.com>**.

Contact: Motorola,
Tel: (0500) 555555.

Nokia Enables Access to WAP

Nokia has announced a new feature for the Nokia WAP Server 1.1 - 'Nokia Activ', a one-button solution that enables Web sites to send WAP service settings, over-the-air, to Wireless Application Protocol (WAP)-enabled mobile phones.

The feature makes offering and using WAP services very easy for both companies and consumers. With Nokia Activ, companies and organisations can immediately offer their services and information to large numbers of mobile phone users in an easy manner.



Consumers would simply click the Nokia Activ button on a Web site and type in their mobile phone number. The settings of the service are sent over-the-air to the customer's WAP-enabled phone as a text message.

WAP is a global standard for communication between a mobile handset and the Internet or other computer application. WAP-based technology enables the design of advanced, interactive and real-time mobile services, such as mobile banking or Internet-based news services, which can be used in digital mobile phones or other mobile devices.

The WAP specification allows solutions from multiple suppliers to perform consistently and reliably for the end-user across digital networks. For more WAP information visit **<www.wapforum.org>**. For further details, check: **<www.nokia.com>**.

Contact: Nokia,
Tel: (020) 7437 4380.

NEWS BYTES

Manchester Airport in Explosive Detection Deal

InVision Technologies, has received an order valued at approximately £1 million from Manchester Airport for a CTX 5500 DS explosive detection system.

InVision Technologies develops, manufactures, markets and supports explosive detection systems based on advanced computed tomography technology for civil aviation security.

For further details, check: **<www.invision-tech.com>**.

Contact: InVision Technologies,
Tel: (020) 8754 9540.

Alcatel and Cambridge Silicon Radio in Bluetooth Deal

Alcatel and Cambridge Silicon Radio (CSR) have announced that Alcatel's Bluetooth-enabled OneTouch 700 and OneTouch 500 GSM phones will contain Cambridge Silicon Radio's BlueCore01 single-chip Bluetooth IC embedded into a battery pack.

Initially, Alcatel plans to use the Bluetooth functionality in the phone for cordless headsets and communication between the phone and Bluetooth-enabled handheld, notebook and desktop PCs.

For further details, check: **<www.cambridgesiliconradio.com>**
Contact: Cambridge Silicon Radio,
Tel: (01223) 424167.

Intel Introduces 933 MHz Pentium III

Intel has introduced the Intel Pentium III processor at 933 MHz. This new processor delivers high performance and is available in high volumes in systems from a wide variety of personal computer manufacturers.

The Pentium III processor at 933 MHz is designed to power advanced desktop software for home and business, including entry-level workstation applications.

For further details, check: **<www.intel.com>**.

Contact: Intel,
Tel: (01793) 403000.

NEWS BYTES

£4 million For New Mobile Phone Initiative - Hewitt

E-Commerce and small business minister, Patricia Hewitt has announced a £4 million research programme into the future development of mobile phone technology.

The programme will be carried out by the Mobile Virtual Centre of Excellence in Mobile and Personal Communications (Mobile VCE). The Government is contributing £1.5m. The rest is being supplied by Mobile VCE's industrial members.

For further details, check: **<www.dti.gov.uk>**.

Contact: DTI, Tel: (020) 7215 5000.

PC Shipments to Grow by Almost 50%

The European personal computer market shows continued strong growth over the next five years, according to the latest forecast by Dataquest.

With a five-year compound annual growth rate of 10.5% in shipments over the forecast period of 2000 to 2004, unit volumes will continue to achieve successive, new, annual records. PC shipments are forecast to surpass 45 million units in 2004.

For further details, check: **<www.dataquest.com>**.

Contact: Dataquest,
Tel: (01784) 431611.

Microsoft to Adopt Biometric Technology

Microsoft plans to incorporate biometric technology in its Windows software that will enable users to sign on by brushing their fingertips across a scanner rather than typing in a password.

Biometric technology scans the details of a person's fingerprints, iris patterns, facial structure or other physical characteristics and compares them against a database of stored user information.

For further details, check: **<www.microsoft.com>**.

Contact: Microsoft,
Tel: (0870) 601 0100.

Rio Digital Audio Receiver Streams Stored Music

The Rio Digital Audio Receiver from Diamond Multimedia enables consumers to stream CD-quality music from a PC to any room in the house. The receiver works with existing phone lines to distribute the digital music collections beyond the home computer.

To date, consumers have only had access to portable players as a way to hear their digital music beyond the PC. Now, consumers can play digital music selections in any room where a Rio Receiver can be placed.

With multiple receivers, various digital music selections can be sent to different locations simultaneously. Individuals can choose what music they want streamed to each Rio Receiver by scrolling and searching their stored collection via controls on the unit, or by using the receiver's remote control.

For further details, check: **<www.diamondmm-europe.com>**.
Contact: S3, Tel: (0118) 9444444.

Fujifilm Launches Latest Compact Digital Camera

Fuji Photo Film has announced the latest addition to its 700 series of digital cameras - the FinePix 4700 ZOOM.

The FinePix 4700 ZOOM is the first digital camera to utilise Fujifilm's new Super CCD for increased sensitivity, improved signal-to-noise ratio and wider dynamic range, attributes that result in sharp, vivid and colourful pictures.

For further details, check: **<www.fujifilm.com>**.
Contact: Fujifilm,
Tel: (020) 7586 5900.

SUPER FUJINON LENS f=8.3-24.9mm
OPTICAL 3x ZOOM
FUJIFILM
SUPER CCD
DIGITAL CAMERA FinePix 4700zoom

Why Aluminium Doesn't Rust

Did you ever wonder why aeroplanes never seem to rust, despite their constant exposure to rain, sleet and snow? The quick answer is that most aircraft are made of aluminium - a chemical element that seems to resist corrosion even when exposed to air and water.

But the fact is that pure aluminium reacts so readily with water that, according to the laws of chemistry, the aluminium shell of an aeroplane should actually dissolve in the rain.

Fortunately for the airline industry, when aluminium metal is placed in the atmosphere, a thin layer, known as aluminium oxide, forms on the metal's surface and acts like a protective, rust-resistant shield.

Scientists have long known that aluminium oxide does not corrode rapidly in water, but they have been unable to fully explain why.

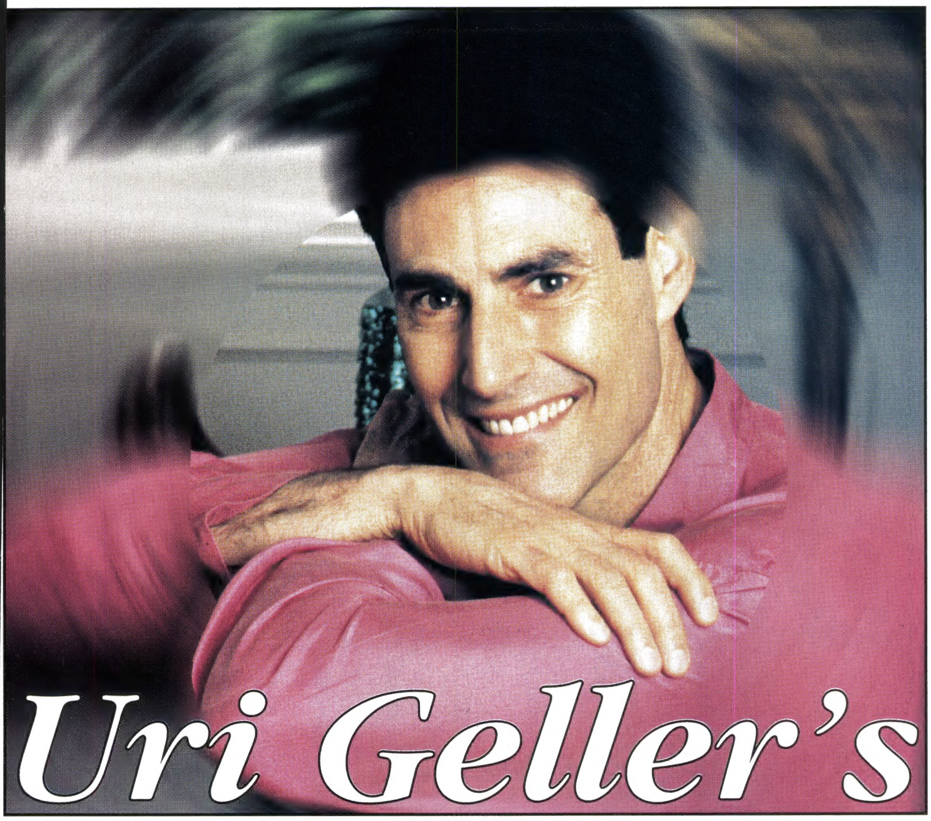
Now, for the first time, researchers have shown that liquid H_2O has a surprisingly potent effect when it comes in contact with the surface of a metal oxide, a finding that has industrial and environmental implications.

Writing in the journal Science, researchers from the University of Chicago present the first atomic-level model of what happens when water and aluminium oxide meet.

Shifting atoms Aluminium oxide consists of atoms of aluminium and oxygen bonded together. But Brown and Trainor discovered that, when water molecules come in contact with aluminium oxide, the aluminium and oxygen atoms on the surface move apart - in some cases separating by more than 50% compared to their normal molecular positions.

As a result, when the outer layer of aluminium oxide gets hydrated or wet, its structure changes just enough to become chemically inert and thus unable to react rapidly with additional water molecules or atmospheric oxygen. This change in molecular structure is why aluminium oxide metal resists corrosion.

For further details, check: **<www.sciencemag.org>**.
Contact: Science Magazine,
Tel: +1 202 326 6417.



Uri Geller's EXTENDED REALITY

Thoughts Through Space

In April, BBC Radio 2 invited me (at rather short notice) to come into the studio for a chat with Lynn Parsons about an item that had appeared in The Independent (17 April) headed 'Arctic explorer tries to be a mind reader.' It described how Arctic explorer David Mill had just set off from somewhere in Canada in an attempt to break the record for a solo walk to the North Pole, which meant that he would have to cover 420 miles in 55 days, arriving around mid-June.

It was not to be an entirely normal expedition. Mr. Mill, who studied psychology at London University, is also interested in parapsychology (the branch of science that reaches the parts other scientists cannot reach). He planned to while away some of the time he would spend tramping over the ice and snow in a series of attempts to record images being transmitted to him - not by radio, but by telepathy - from an unnamed team somewhere in the U.K.

At the end of the experiment, Dr Caroline Watt, a research fellow at the Koestler parapsychology unit at Edinburgh University, would study the results. She would assess whether Mr. Mill's impressions matched the images beamed at him to a significant degree, or if nothing more than chance/guesswork was involved.

Dr Watt mentioned that the experiment hoped to repeat that of the famous explorer Sir Hubert Wilkins back in the 1930s, who did indeed seem able to communicate mind to mind with a friend in New York.

Now, as it happens, I met that friend briefly soon after I arrived in the U.S.A. in the seventies, and did not know much about who was who in the psychic world. His name was Harold Sherman, a successful writer who also had remarkable abilities in the area of telepathy and clairvoyance. He had just published his ESP Manual (1972), one of the best practical guides to expanding the mind I know of. One of his dozen or so other books was Thoughts Through Space (1942) in which he tells the whole story of what has to be the most remarkable series of experiments of their kind ever recorded.

It all began when Wilkins was chewing the fat with his friend and fellow club member in New York about his forthcoming plan to search for a Russian aeroplane missing on a flight from Moscow over the Arctic Ocean. He knew that communication was going to be difficult - sunspot activity in 1937 was the highest recorded for nearly seventy years, meaning that his radio link would be very unreliable. It was in fact frequently knocked out altogether. So, Sherman, suggested, why don't we see if telepathy gets through when radio doesn't?

Wilkins liked the idea. He remembered from his boyhood in Australia that the Aborigines made regular use of telepathy and precognition, so he knew it could be done. Sherman was equally convinced by his many years' experience of psi phenomena, They agreed on a routine: Wilkins would keep a diary, sending it when he could in instalments to a third party for witnessing, and Sherman would note down his impressions picked up at prearranged times. These would also be witnessed as they were made, so nobody could accuse either man of fiddling with the data after the event.

Wilkins headed north on 25 October 1937, and over the next five months Sherman was able to record a total of 68 reports containing nearly 300 specific statements.

The results were astonishing. As Wilkins himself concluded "You seem to get all the very strong thoughts and sense the vivid conditions." Not surprisingly, Sherman got a lot about ice, snow, and cold, but some of his impressions seemed quite out of place. One evening, for example, he wrote "You in company, men in military attire... evening dress, important people... You appear to be in evening dress yourself."

Who would imagine that an Arctic explorer would be in evening dress? However, on the evening in question Wilkins had been invited to an Armistice Ball attended by the local top brass - and yes, Wilkins was wearing a (borrowed) evening dress suit.

Soon after that direct hit, Sherman scored another. "Some kind of banquet ... seem to see it held in church... connection school, standing in front of blackboard, chalk in hand, you give short talk." At the time, Wilkins was attending a banquet in Missionaries' House, Point Barrow - about 4000 miles from New York - and that day he had given a short to talk to the local schoolchildren. Yet another 'coincidence', of course.

So it went on and on. Sherman made notes about a fire, a funeral, a ladder, and a diamond mine. Wilkins had seen both a fire and a funeral, had needed to use a ladder, and did have toothache. In fact, the only time when psi-communication seemed to go adrift was when they were doing some card-guessing. Wilkins found this tedious and clearly did not try very hard and results were close to chance.

This is just what Mr. Mill and his team is doing as I write (in May) and I would not be surprised if they got the same result, as I told Lynn Parsons in April. Wilkins succeeded because his survival was at stake and he had worked out a code for emergency signals which luckily he never had to use whereas Mr. Mill's team seem to be merely carrying out an academic exercise. And telepathy usually only works when it has to work.

Uri Geller's novelS *Dead Cold* and *Ella* are published by Headline at £5.99. *Mindmedicine* is published by Element at £20. Visit him at **www.uri-geller.com** and e-mail him at **urigeller@compuserve.com**

Uri Geller

PC Controlled DISCO LIGHTS

Rob Heslop describes a simple to build disco light system for all budding DJs

Introduction

The following text describes an interface unit, which allows the user to switch a set of disco lights on and off, via a computer. The unit connects up to the LPT (printer) port on the back of almost any PC, and is controlled via a simple set of software commands. The two pieces of output software, detailed below, allow the lights to be manually turned on or off using the keyboard, or turned on and off automatically, in a series of predefined patterns.

PROJECT PARTS LIST

Resistors:		**Miscellaneous:**	
R1 - R8	680Ω	Tran1	Transformer
			Secondary 15V-0-15V
			0-230V AC Primary
R9 - R16	390Ω 1W		Bulgin Sockets x 2
R17 - R24	330Ω 1W		25 pin D Plug
R25 - R33	39Ω 1W		Hood for Above
			9 Core Cable
			13A Mains Flex
Capacitors			13A Plug
C1 - C8	22nF 600V		Single Core Mains Cable
	polypropylene		
C9	100µF 35V		
	Electrolytic		Heat Shrink
C10	10µF 35V		
	Electrolytic		Box
C11	100nF Polyester		Cable Glands
			Heat Sinks
			Strip Board
			Semiconductors
			Stand Off
IC1	2803		Hardware
IC2 - IC9	3041	FS1	500mA Fuse + Holder
TR1 - TR8	BC08A 600B	FS2	Fuse + Holder
IC10	LM7812		To suitable lamps used
D1 - D4	1N4001		

Circuit Description

The circuit is relatively simple as the LPT port outputs data on eight data lines (D0 - D7), along with read write, enable and such like. Luckily the port outputs the data constantly, unless it is instructed other wise, this means that no latches are required in the interface unit.

The LPT port connects directly into IC1 an octagonal Darlington buffer. IC1 was used because the output of a LPT port is at TTL levels, so a logic one can be less than 3V, which may not be enough to drive IC2 - IC9 the opto-isolators. The power circuit is a relatively common approach, and similar circuits have featured in several previous articles.

When current flows through the LEDs in IC2 - IC9 the triac stage starts to conduct, this is used in turn to activate TR1 - TR8, the power triacs. IC2 - IC9

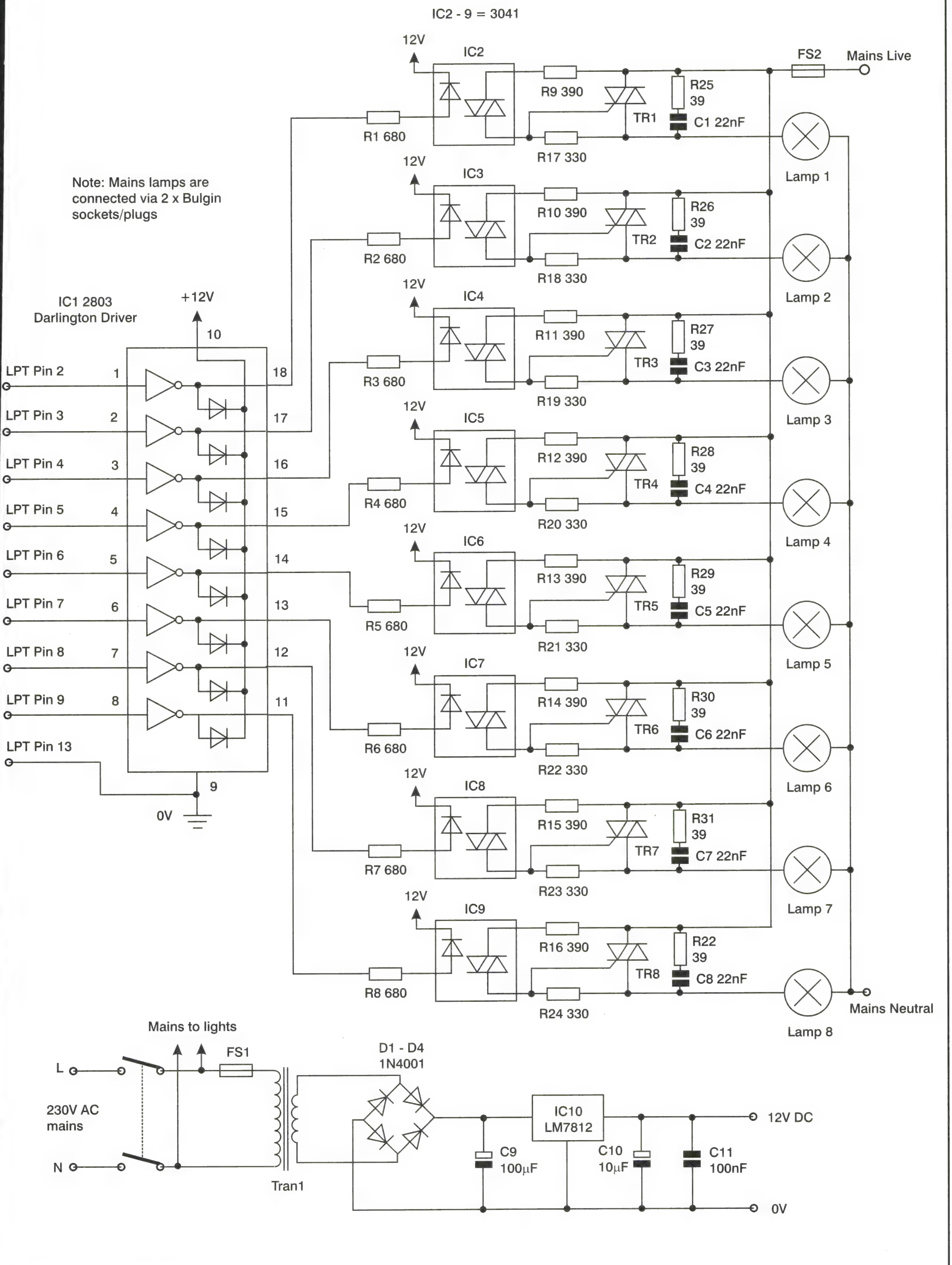


Figure 1. Complete Circuit

Box

not only electrically isolate the PC from the mains but they also eliminate the need to calculate the gate currents in TR1 - TR8. For the main triacs, BTA08 600Bs were chosen for a combination of power handling and the fact that they had isolated tabs, allowing common heat sinks to be safely used.

Resistors R9 - R24 connect the opto-isolators to the triacs, and limit the current. While resistors R26 - R32 and capacitors C1 - C8 act as traps, which remove mains spikes.

The power supply is based around IC10, an LM7812 voltage regulator, along which D1 - D4 which act as a rectifier. The resultant DC is first smoothed by C9, before being regulated by IC10, which produces a 12V output. Capacitors C10 and C11 provide high and low frequency decoupling, for the power supply.

Circuit Construction

When building the circuit great care should be taken as live mains can be fatal, and electrical safety procedures should be followed, refer to issue 83 for details on mains safety. The prototype circuit shown in the attached pictures was built on two strip boards, as PCB fabrication was not a viable option. To aid power handling the main triacs were not mounted on the boards and the current flowing on the boards was limited to a few mA. This increased the wiring greatly, but the safety aspect seemed to justify it.

Standard assembly procedure was used to build the boards, placing smaller components first; great care was taken to ensure no tracks were accidentally bridged. After the circuit boards were built, the triacs were mounted directly onto the heat sinks, and the whole circuit was connected up using single core mains cable. All mains connections were then insulated using heat shrink, to prevent risk of short circuits. The whole project was then mounted in an ABS box, with the output to the light being provided by two Bulgin connectors, one for channels 1 - 4 the other for channels 5 - 8.

Testing

After the circuit was built and checked for visual defects the whole thing was checked with a continuity tester, to make sure that there was no short circuits. Great care was taken at this stage as a short circuit could be fatal to the user or the PC. Iniitally, 5V was applied to each of the inputs in turn. The current flowing through R1 - R8 was then measured to be a couple of milliamps, which is about correct to supply the LEDs. The circuit was then connected to the mains, with load on each output (in this case a light bulb). Then 5V was applied to the appropriate input, to check weather the circuit was operating correctly. The last stage before connecting the interface up to a PC was to check for stray voltages on the 25-pin D connector, it's better to be safe than very sorry!

Software Design

The software for the interface was written in C and the two attached code listings allow the lights to either be switched on and off via the keyboard, or automatically turned on and off in a set pattern.

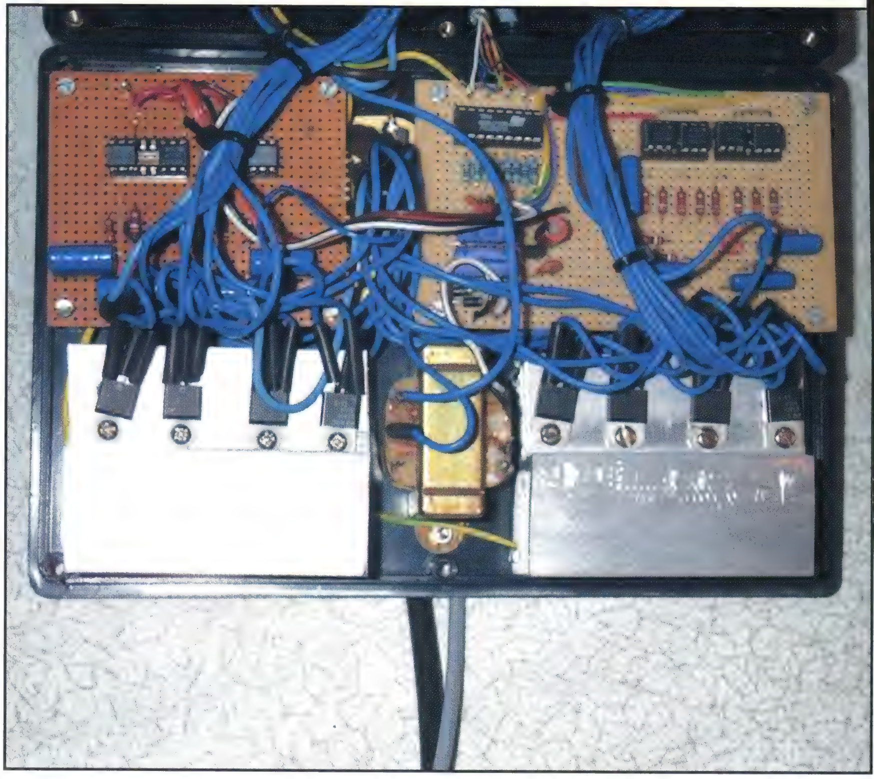
The codes are based around the instruction "outportb (0x378,'Y')". This instruction outputs the decimal value 'Y' on the LPT port in binary with data0 as the least significant bit. Based on which lights you require to turn on or off, you can output the appropriate value on the LPT port, see table 1.

Pin	Function	Pin	Functio
1	E	14	R/W
2	Data 0	15	N/C
3	Data 1	16	RS
4	Data 2	17	E2
5	Data 3	18	GND
6	Data 4	19	GND
7	Data 5	20	GND
8	Data 6	21	GND
9	Data 7	22	GND
10	+5V	23	GND
11	+5V	24	GND
12	0V	25	GND
13	0V		

LPT Port Wiring

Important Safety Note

It is important to note that mains voltage is potentially lethal. Full details of mains wiring connections are shown in this article, and every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit, which should never be operated with the box lid removed. Safe construction of the unit is entirely dependent on the skill of the constructor, and adherence to the instructions given in this article. If you are in any doubt as to the correct way to proceed, consult a suitably qualified engineer.


Internal details

Light No.	Light 1	Light 2	Light 3	Light 4	Light 5	Light 6	Light 7	Light 8
Decimal No.	1	2	4	8	16	32	64	128

For Example lights 3,4, & 7 on

Light No.	Light 1	Light 2	Light 3	Light 4	Light 5	Light 6	Light 7	Light 8
Decimal No.	1	2	4	8	16	32	64	128
Binary No.	0	0	1	1	0	0	1	0

= 4 + 8 + 64 = 76 decimal

Table 1

Switch Code (keyboard input)

```
include <dos.h>          /* Contains the prototype for
utportb */

nt main(void)       /* Main program */


nt input, lite1=0, lite2=0, lite3=0, lite4=0;

* Define the variables, ie. the lights and set them to
 */

lrscr();  /*clears the screen */

otoxy(25,12); printf("type 1-4 to turn lights 1-4 on or
ff");
otoxy(25,13); printf(" press Esc to exit ");

* Print instructions in the middle of the screen */

o    /* Start of loop */

nput=getch();  /* Read ASCII value from keyboard */

     {
     if (input==49)            /* Do the following
when 1 is pressed */
          if (lite1==1) lite1=0;     /* If light 1 is
turned on turn it off */
          else lite1=1;        /* Else turn it on */

     if (input==50)            /* Do the following
when 2 is pressed */
          if (lite2==2) lite2=0;
          else lite2=2;

     if (input==51)            /* Do the following
when 3 is pressed */
          if (lite3==4) lite3=0;
          else lite3=4;

     if (input==52)            /* Do the following
when 4 is pressed */
          if (lite4==8) lite4=0;
          else lite4=8;

     outportb(0x378, (lite1 + lite2 + lite3 + lite4));
```

```
/* Set the output on the LPT port based on which
lights are turned on */

     }
while(input!=27);           /* Repeat loop until Esc
is pressed */

outportb(0x378,0);    /* Set the output on the LPT
port to 0 */

return 0;             /* End program */
}
```

Run Code (automatic switching)

```
#include <dos.h>      /* Contains the prototype for
outportb */

void main(void)       /* main program */
{

do                    /* start loop */
{
outportb(0x378,1);    /* Turn light 1 on only */
delay(300);                /* Wait 300ms */
outportb(0x378,2);    /* Turn light 2 on only */
delay(300);                /* Wait 300ms */
outportb(0x378,4);    /* Turn light 3 on only */
delay(300);                /* Wait 300ms */
outportb(0x378,8);    /* Turn light 4 on only */
delay(300);                /* Wait 300ms */
}
while (!(kbhit()));   /* repeat loop until any key is
pressed */

outportb(0x378,0);    /* turn all lights off */
}
```

It is worth noting that 0x378 is the LPT port address in hex, it may differ from PC to PC although 378 is becoming standard (some PCs have 278). If you are not sure what the value can be, check in settings/control panels/system/device manager/ports.

Either of the example codes can be compiled and run as they are, or with a bit of imagination they can be adapted to the requirements of the individual user. Also precompiled software is available to download from the Internet at **www-users.york.ac.uk/~rah110/**

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MINICRAFT®

MINI REVIEW

Circular Saw Table

Ever wished you could cut your piece of modelling wood or metal in a straight line and at speed without the hassle of using a small handsaw? If the answer is yes then this 0-18VDC 100watt Circular saw bench just has to be an ideal accessory; not just for modellers but for general innovative small time use aswell. Not only will it cut balsa wood or small pieces of wood but it will cut plastics, PCB boards and metal too, all with ease. The 84 tooth saw blade provided here would cut plastics, fine wood and non-ferrous metals up to 2mm. The second saw blade will cut coarse woods and other soft materials up to 5mm. The parallel and bevel guides provided gives you the flexibility to cut at a variety of different angles. The saw runs from a 0-18V DC supply and Minicraft make two power supplies that will operate it There is a 24VA Variable Supply (Maplin Order code XP19) or 50VA variable supply (Maplin Order code BA83).

The Circular saw table is available from Maplin Electronics.

(Order code XP18U Price £53-99

High Precision Drill Kit

If you don't have a mini drill for modelling purposes then this kit is a good starter pack. For the carrying case contains a 100watt 12V hand-held drill, variable power supply and 40 useful accessories. These accessories will perform drilling, cutting, grinding, routing, shaping, polishing and sanding. The drill is particularly useful for drilling out PCB component holes, cutting and shaping PCB boards and case holes, trimming and polishing front panels and de burring holes in metal cases. A range of other accessories are available for the drill. See the Maplin catalogue for details.

This kit is available from Maplin Electronics.

(Order Code XP20W Price £84-99)

Engraving and Security Kit

For all you budding Leonardo's that fancy decorating your wineglasses or the glass fanlights over the door, this engraver is a must for the creative artist and illustrator. You can even create your favourite designs on copper sheet and then buff it up using the Minicraft polishing tool. Security marking video recorders or any other item of value is an easy task. The kit comes complete with 3 tools and an alphanumeric stencil. The kit is available from Maplin Electronics.

(Order code BA86T Price £29-99)

Software HINTS & TIPS

by Mike Bedford

Word 97 can't actually write for you but some of its facilities come close.

Here we look at the various language tools.

I guess just about everyone who uses Microsoft Word makes use of the spell checking facility - after all, it's a simple matter of clicking on the 'tick' icon on the standard toolbar. However, there is far more to Word's grammar-related features than this alone. Our subject this month is making the most of the language tools.

Checker Beware

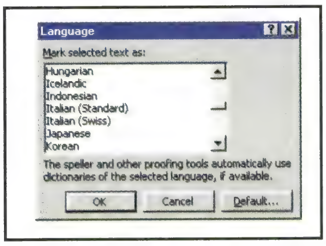
If you are new to word processing and haven't actually made use of the spell checker yet, simply click on the following icon which you'll find at the top of the screen.

Word will then look at every word in your document (or in the selected portion if you highlighted a section of the text first), and will stop at every word which it doesn't recognise as a word of the English language. Normally it suggests some words which you might have meant and you can either pick one of these, type in your own correction, or tell it to ignore the erroneous word. You would normally use this latter option because the word in question is one you know to be correct even though it isn't in Word's dictionary. Place names are a common example of 'wrong' words you would tell it to ignore.

I guess that most Word users will be familiar with the spell checker at this level. However, there are some traps it is all too easy to fall into - the spell checker isn't a universal panacea. Some people object to spell checkers on the grounds that it conditions people to be lazy. However, I am not thinking about the effect it may have on standards of literacy. It is all too easy to accept one of Word's suggested 'corrections' without looking at it properly. In cases like this you could end up with a document which contained no wrongly spelt words but does contain some words which are not the ones you intended. It's a wise precaution, therefore, to re-read a document once you've checked it, just to make sure that you haven't got some totally wrong words in there due to an incorrect correction. Another option, which is provided when Word finds a suspect word, is to add it to the dictionary. Now, every time Word comes across the word in the future, it will no longer flag it as a potentially wrong word. However, this is another area in which care is necessary. Before pressing that Add button, do double check that you had genuinely spelt the word correctly. If you had not and you clicked on Add, Word will not recognise it as wrong if you spell the word in the same wrong way in the future.

Foreign Languages

If you write in languages other than English, then there's clearly no point in spell checking your document in the normal way since a very high proportion of words which are correctly spelt will be flagged as potentially wrong because they're not in Word's dictionary of English words. If you're a foreign user writing in a language other than English all the time then Windows will have been configured accordingly and Word will use the appropriate spell checking dictionary. However, there are ways of telling Word to spell check a document or a part of a document using a foreign language dictionary, even if you normally work in English. To do this, highlight the portion of text you want to be marked as a particular language and select Tools > Language > Set Language... Now simply select the required language from the following list that will be displayed.



Mark selected text as:

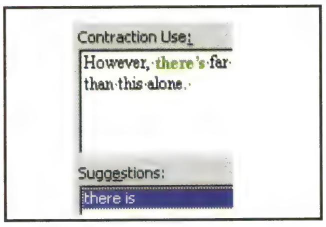
Hungarian
Icelandic
Indonesian
Italian (Standard)
Italian (Swiss)
Japanese
Korean

The speller and other proofing tools automatically use dictionaries of the selected language, if available.

You'll notice that there are some pretty obscure languages listed. In fact it is highly unlikely that you will need to write in a language which isn't included (except, of course, for languages which don't use Latin script and which, therefore, need a specialist word processor). However, in all probability, unless you have installed it already, the appropriate dictionary won't be on your system. To check, just try to spell check your document - if Word complains that the dictionary is missing you will have to buy it from Microsoft. Specialist dictionaries containing, for example, medical terms, are also available.

Grammar

In addition to checking the spelling of a document, you can also check the grammar. Although this facility can be useful, though, be aware that grammar checking is much more difficult than spell checking so the suggestion should be treated with rather more caution. To check the grammar along with the spelling select Tools > Options... > Spelling & Grammar and then, in the lower portion of the window, check the Check Grammar with Spelling box. You can also select the style of writing from the Writing Style list box - Word will use different rules for a formal document from the ones it would use if you're aiming for a casual writing style. Now, when you do a spell check, the grammar will be checked also. To differentiate the two, suspect grammar is highlighted in green whereas suspect spelling is highlighted in red as usual. In the following example, I had selected a formal writing style and Word had objected to my use of a contraction - i.e. 'there's' instead of 'there is'.



Contraction Use:

However, there's far than this alone.

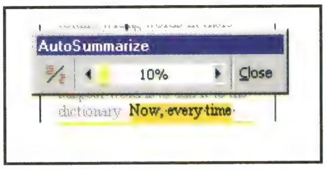
Suggestions:

there is

Summarisation

Another facility you might like to experiment with is the auto-summarisation tool. Personally I've not found it to be particularly effective but you may just find a use for it. In theory it's meant to pick the key points from a document to produce a shorter summary. You tell it the size of the summary required and whether you want the summary to be highlighted, the summary to be inserted at the top of the document, the summary to be written to a new document, or all but the summary to be hidden. To try this out, select Tools > AutoSummarize... Here I've asked word to produce a 10% summary of this document but I've got to say that the sentences highlighted are not the ones I'd have chosen.

As usual, I've only managed to scratch the surface with this single page introduction to Word's language-related features. And as usual, my suggestion is for you to delve further yourself to discover more of these facilities. I've already mentioned the Spelling & Grammar tab of the Options... window which is found on the Tools menu. This would be a good place to start your voyage of discovery. Here you can choose to check spelling and grammar on the fly, you can tell it where to store words you want to add to the dictionary, and you can even be very specific in selecting which rules you want Word to use for checking spelling and grammar.



dictionary. Now, every time

RESEARCH NEWS

by Dr Chris Lavers

21st Century Liquid Crystal Displays Today for the Needs of Tomorrow

In this final part, Dr. Chris Lavers looks at the latest LCD technology and what we can expect in the future.

In Part A of our short look at the dramatic developments in Liquid Crystal Display (LCD) technology we looked briefly back to the origins of the different kinds of liquid crystal phases, first noted by Reinitzer in 1888: particularly the nematic, cholesteric, and the smectic phases. In this second part I want to look into the possible future of LCD applications and liquid crystal devices for sensing and communications applications.

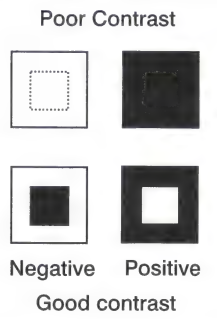


Figure 1. Contrast of a pixel element.

Passive LCD Technology

Currently the industrial electronics marketplace is the singlemost largest user of passive LCD technology. This technology includes dichroic, twisted nematic (TN), supertwist nematic (including STN, FSTN, and DSTN), some of which we shall be looking at in a little more detail. There is growing interest in Thin Film Transistor (TFT) or Active Matrix LCD's due to increases in possible switching speed and display stabilisation. Active TFT technology, as opposed to conventional passive matrix technology, also helps to 'stabilise' the pixel (display element) state until 'readdressed' with a fresh applied voltage, which combined with bistable ferroelectric liquid crystals helps to maintain the highest black/white 'contrast ' ratios possible.

Some discussion of image contrast and display segments is useful. Contrast is the ability to clearly distinguish the display element against its background in either a positive or negative format. Basically to see the pixel against its background it must be either much lighter or darker than its background. This basic principle in fact applies to any energy band and not just in the visible. A thermal or radar image is only seen if the object being viewed or detected respectively is highly distinguishable from its background. The sections of the LCDS that act as microscopic shutters turning 'on' or 'off' the display elements are known as segments. Segments are created by optical lithography and etching to produce transparent Indium Tin Oxide (ITO) electrodes patterned onto the internal LCD glass surfaces. Numbers and letters can be formed with only a 7-segment digit. A 16-segment digit can form all the numbers and letters, but a Dot Matrix (5 by 7 pixels) is often preferred as it creates a more aesthetically pleasing display script similar to conventional newspaper print (see Figure 2).

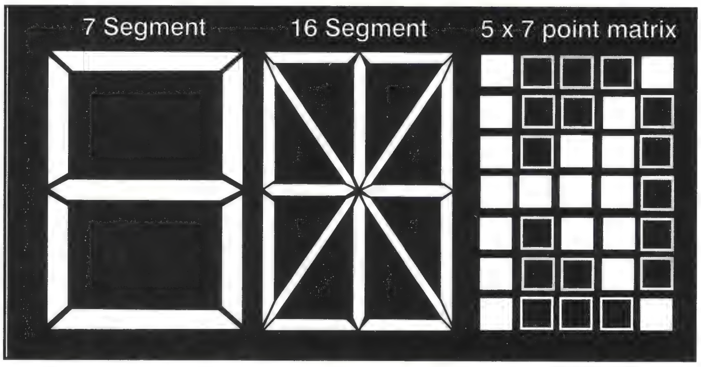


Figure 2 Pixel display types: a) 7-segment, b)16 segment,and c) Dot-Matrix segments. Courtesy Crystaloid.

A display screen made with a Thin Film Transistor (TFT) is a liquid crystal display now common in notebook and laptop computers that has an individual transistor for every pixel. Each tiny pixel element controls the illumination of your display. Having a transistor at each pixel means that the current that triggers pixel illumination can be significantly smaller and therefore can be switched on and off more quickly, and is more responsive to change. The most common example of this is when you move a mouse across the display screen, particularly a large display, a TFT display responds fast enough to match the mouse cursor movement. With a passive display, the mouse cursor momentarily disappears until the display can catch up with the change. The bigger the display the greater the delay. Displays are a vital part of industrial and personal consumer products throughout the world. They have now become major devices in the performance of computing, medical imaging and process control, and have become pseudonymous with electroni arcade entertainment and can be found in videos, kitchen appliances and portable computers, not forgetting the digital wristwatch. Recent sing TFT panels have been fabricated with a diagonal a lit over 28 inches. Philips TFT programme involves universities in Paris, Rome, th Einhoven University of Technology in Holland and th Dutch Polymer Institute. The first TFT was made in the USA back in 1972 using the semiconductor Cadmium Selenide.

According to a recent publication the value of worldwide shipments of electronic displays was $35.9B in 1998 and is projected to grow to $46.4B by 2001, reflecting an average annual growth rate of 9%.

The market for this astonishing growth in electron displays is driven by the high value applications of TV and information processing. Continued growth is projected for displays as consumers increasingly invest, rightly or wrongly in what they regard as high technology products. Although heralded for at least a decade as the successor to the Cathode Ray Tube, the CRT remains robustly resistant to attacks from this relatively 'new comer' of liquid crystal flat panel technology. A mature attitude would be to consider the relative merits of the two different class of device for the particular application in mind. The reality is that there is more than enough marketshare for both technologies to grow well into the next decade at least. To be fair penetration of the CRT market by flat panel displays has been increasing for the last couple of years. Flat panel technology is becoming less pseudonymous with liquid crystal displays, as new display technologies, such as plasma, vacuum fluorescence, light emitting diodes, electroluminescent materials and field emission displays enter the market. However liquid crystal technology still accounts for approximately 82% of existing flat panels sold globally. In 1998 flat panel displays sold valued 12.106 B$ and is projected to rise to 17.37B$ in 2001.

There are many monitor displays being developed currently by several leading

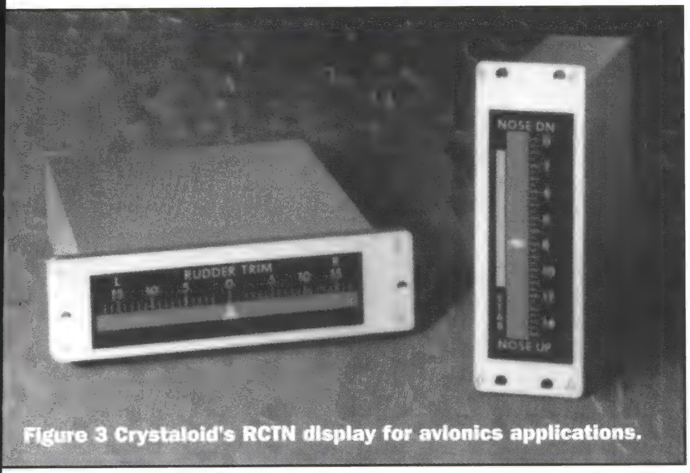


Figure 3 Crystaloid's RCTN display for avionics applications.

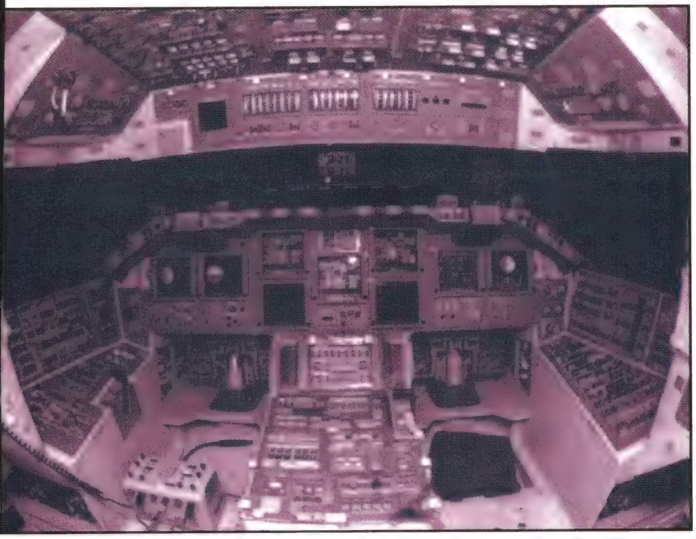


Figure 4 The glass cockpit installed in the orbiter Atlantis. The current Columbia upgrade will provide easy-to-read, graphic portrayals of key flight indicators such as attitude display and Mach speed. Courtesy NASA.

display manufacturers, including Sharp of Europe Limited in the UK, based near Oxford and Philips in Holland. Let us have a look at some areas of current and recent research by Oxford.

A Wristwatch-Type Personal Information Manager

This is basically an ultra small Personal information tool that can receive short range FM teletext broadcasts and includes a Personal Handyphone System acting as a portable phone. It will handle various types of information, and perhaps be compatible with Third Generation mobile phone technology - an area for an up and coming future Research News. In conjunction with developments of an ultra low weight, compact, high quality photographic lens LCD still-image camera with a fast half-duplex optical communications link will allow 2-way transmission and monitor applications. Screen update for this size of display is unlikely to present any technological problems. However, it must be noted that with the notable exception of video-conferencing applications, the videophone concept has not been especially well taken up by the general public who after all are the aimed end customers. Recently Motion Media has begun to offer a suitable video-conferencing phone for the higher quality end of the market and perhaps in the next few years children will grow up with this sort of technology and take it as the norm. Personally one of the few links I have seen is the not-quite real-time video-phone link between Goonhilly Earth station and Land's End in Cornwall! Sharp are also working on multimedia-compatible notebooks, using reflective full-colour LCDs, or 'industrial paper' exactly as a paper notebook, as well as being able to receive satellite broadcast communications, similar to GPS reception. This notebook has an advanced handwriting recognition feature that allows easy cut and paste editing and correction. Simple palmtop character recognition systems are now becoming quite common amongst executive types and are priced reasonably for wide availability in the next two or three years.

Several companies have developed modern versions of Twisted Nematic (TN) displays including Crystaloid in Ohio, USA. Their popular Reverse Contrast Twisted Nematic TM (RCTN TM) LCDs have extra wide viewing angles and high contrast ideal for avionic applications and have been used by aviators since 1994. Aircrew may need to glance over to displays at quite large incident angles to ascertain certain flight critical information (see Figure 3). NASA has taken this requirement a stage further for modifications on the recently refitted Space Shuttle Columbia, the oldest of the four shuttles and a veteran of 26 flights that should be completed by July 2000. The orbiter has been outfitted with a Multifunctional Electronic Display System (MEDS) or 'glass cockpit' - see Figure 4. Columbia follows the Shuttle Atlantis, which now has full-colour, flat-panel liquid crystal displays, installed on its flight deck. The new system improves crew interaction with the orbiter during flight and reduces the high cost of maintaining the outdated electro-mechanical cockpit displays currently on board. In addition a space-to-space orbiter radio and wireless video modification will increase communications capabilities for Columbia's future crewmembers and those outside working on the ISS assembly!

Cells Old to Modern

One of the first demonstrated liquid crystal devices was the voltage-dependent optical activity of a twisted nematic liquid crystal developed by Schadt and Helfrich working at Hoffmann-La-Roche Co. in Basel Switzerland in 1971. At high enough applied voltages for a liquid crystal filled cell with the surface alignments 90° apart, the applied voltage can cause the alignment in the bulk to be practically parallel to the field (see Figure 5). For $10\mu m$ thick samples transmission switched suddenly between a transmissive and a non-transmissive mode with only a mere 3V at a driving frequency of 1kHz.

Before TN displays could become commercially successful it was necessary to synthesise liquid crystals for room temperature operation. In fact early on it was established that LCD displays exported to Africa often failed because of unanticipated temperature induced phase changes! In 1972 George Gray and Ken Harrison at Hull University in the UK synthesised stable, colourless liquid crystal mixtures between -10°C to 60°C based upon so called cyanobiphenyl compounds. TN displays rapidly found niche markets in digital watches and

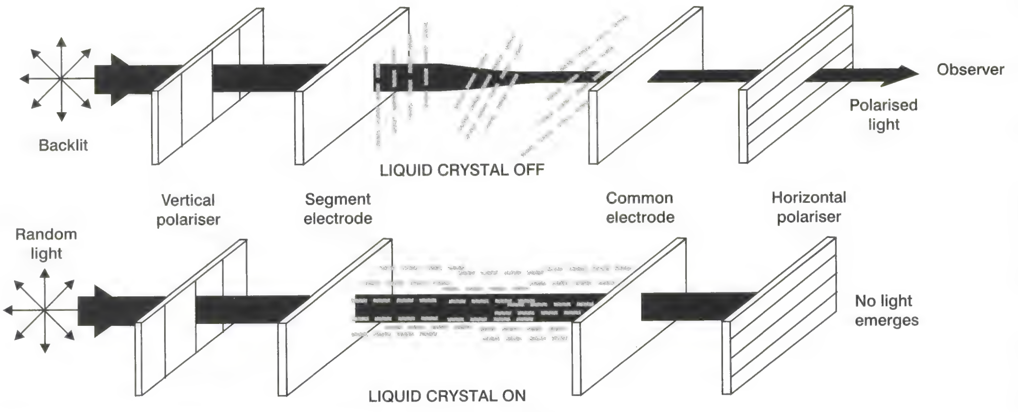


Figure 5 Twisted nematic cell without voltage and with voltage applied.

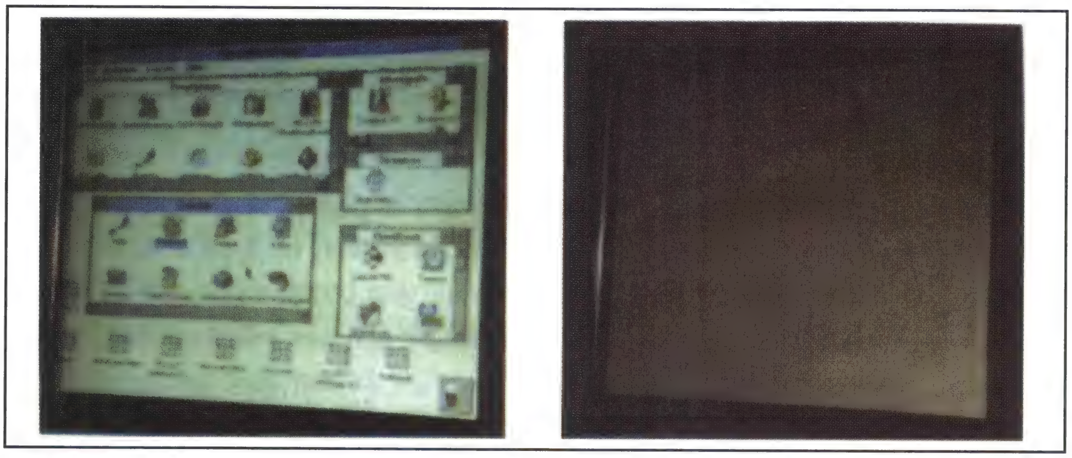


Figure 6 ATM PDLC display operated in a) wide viewing and b) narrow viewing display mode.

calculators fairly quickly. However, the number of display elements (pixels) that could be incorporated into the display was limited, and only overcome with the development of TFT active matrix displays.

At about the same time that Schadt and Helfrich were working on their nematic displays, Heilmeier in RCA Laboratories, Princeton, New Jersey had been less concerned with transmitted light but with scattering induced changes for reflective displays. However, with no electric field applied light is nonetheless transmitted. In its voltage applied or 'excited' state the liquid crystal material scatters the incident light, thus reducing the amount of transmitted light with 'on' to 'off' ratios greater than 20:1.

We reported recently in Research News a liquid crystal display providing a backlit system with variable viewing angles for Automatic Teller Machines (ATMs). The use of a Polymer Dispersed Liquid Crystal (PDLC) has a different luminance as a function of viewing angle in its scattering and transparent modes of operation (see Figure 6). In operation Dr Kalfass' display in Stuttgart is very impressive for 30 degrees viewing in wide viewing mode (scattering) and narrow restricted viewing mode (transparent). National Cash Registers has applied for a patent on the developments. The introduction of low molecular weight liquid crystals in a polymer matrix forms a new class of non-linear optical materials which have strong potentials in applications such as large-scale, low-cost, devices exhibiting high brightness without the requirement for polarisers as used in conventional cells. Polymer cells also make the cells more robust against bending and dropping! PDLCs can be switched electrically between opaque 'off' and transparent 'on' states. Liquid crystals form droplets whose size depends on the fabrication method used.

In the mid 1980's Yasayuki Okamura and his colleagues at Osaka University demonstrated that nematic liquid crystal coated flat or 'planar' waveguides could be used to demonstrate electro-optic switching with as little as 4V applied with fast switching times of only a few milliseconds, see Figure 7. Unfortunately this concept has developed little over 2 decades although the Optics Department at the Cybernetics Institute in Naples have demonstrated 'on' times of 400μs at a frequency of 100Hz. Nematic liquid crystals have also been used successfully to demonstrate an optical Spatial Light Modulator (SLM). A probe beam reflected from a surface adjacent to a nematic liquid crystal, which can be modulated with an applied voltage across the liquid crystal layer, will transfer the voltage modulation into a weak amplitude modulation of the reflectivity of the probe beam. Yeatman at Imperial College demonstrated this concept successfully in 1989. In addition in the late 1980s US workers led by Professor Noel Clark at Boulder in Colorado did start to look at ferroelectric liquid crystal coated waveguides with 'theoretical' faster switching times.

Although modelling of the liquid crystal alignment within nematic liquid crystals has been relatively well understood for some time, ferroelectric liquid crystals have not been so easy to fathom. Complicated analytical expression can be found to help describe the 'global' response of millions of nematic liquid crystal molecules in a variety of configurations. Such analytical expressions for the ferroelectric liquid crystal phase are few and far between and are mostly due to the patient and enduring work of Dr Frank Leslie at Strathclyde University in Scotland. Optical data and multilayer modelling for ferroelectric liquid crystal cells was developed by Elston and Sambles at Exeter University, UK. This enabled horizontal tilt, or so called in-plane tilt, of the molecular axis to be determined as well as the vertical (out-of-plane) tilt using a theoretical expressions similar in some respects to those used in nematic theory and then trying to fit real experimental data to various theory models!

In this way models were found that worked and more importantly models were found that began to help explain what was going on under an applied voltage. It turned out that the Vertical tilt took the form $(2/\pi)C$ arctan $(A\sin^2 (z(\pi-B)/d+B)$, where $(2/\pi)C$ controls the maximum value of tilt, d is the half cell thickness, and A a function of applied rms voltage. The horizontal tilt is found in similar way. In our own work, good comparisons of theory with data (see Figure 8) allowe values for the constants A,B,ar C in the above expression to b found.

Out-of-plane tilt and in-plan tilt profiles can be obtained as function of voltage - see Figur 9 - which shows typical tilt profiles for the ferroelectric liquid crystal MIX 783 in a 3.5μm thick cell as a function applied voltage. Note the 'pinned' Chevron defect discussed in Part A clearly visible in the middle of the cel Work conducted with convention X-ray scattering shows that the defect is usually strongly pinne in the middle of the cell but some samples have been observed with a small shift to one or other side. Strange though it may seen the energy involved with a single abrupt discontinuity in the middle of the cell is less than that associated with any other likely cell defect or deformation.

Unfortunately, milliseconds switching speeds are too slow for modern communications requirements, although the use of nematic and cholesteric liqui crystals as sensing elements, usually temperature sensing are still under investigation. See part A for an encapsulated liquid crystal planar waveguide thermal sensor.

Workers at OptoSci Ltd in Glasgow and the Optoelectronic Division in the University of Strathclyde have demonstrated low voltage wavelength tuneable filters with the nemati liquid crystal E7 on a planar waveguide showing wavelength dependent transmission (see Figure 10). This may lead to a number of commercial devices for both sensors and communications applications.

In 1982 Dr Waters and Dr Peter Raynes FRS, Head of Liquid Crystal Research at DERA Malvern, developed the SuperTwist Nematic (STN). Liquid crystal molecules aligning in a cell between surfaces with a natural twist

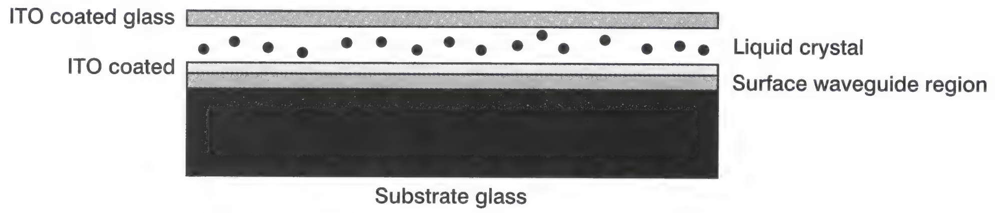


Figure 7 Electro-optic Nematic liquid crystal cell, PCH1132, incorporated into a planar waveguide.

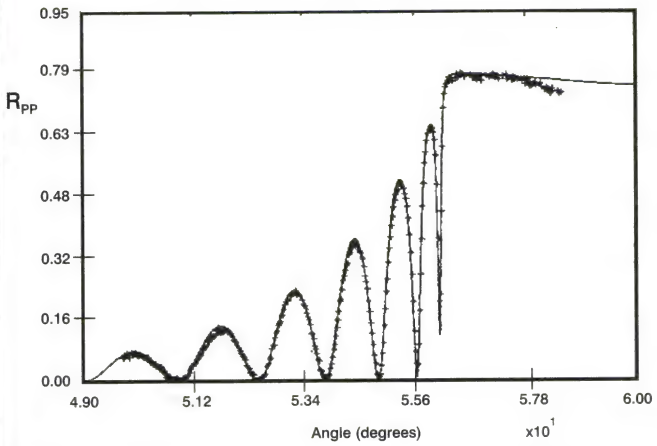


Figure 8 Reflectivity for incident TM polarised and reflected TM polarised radiation from a 3.5 micron thick ferroelectric liquid crystal cell.

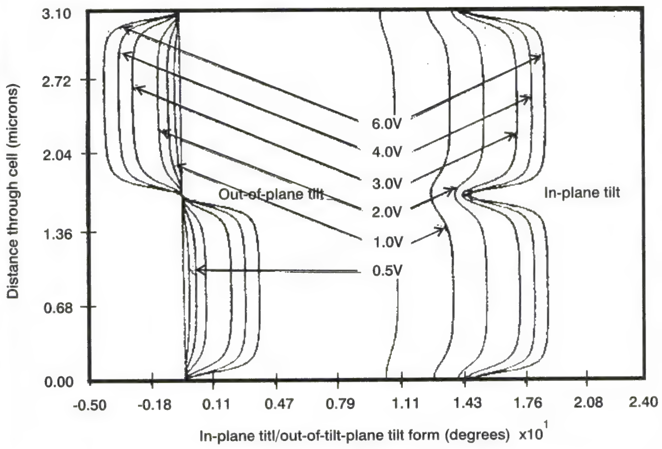


Figure 9 In-plane and out-of-plane tilt profiles as a function of applied voltage.

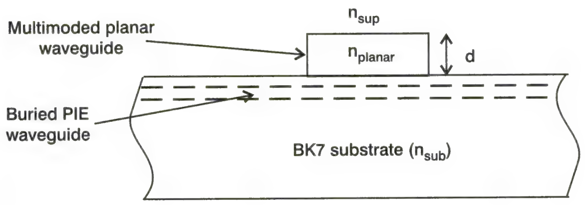
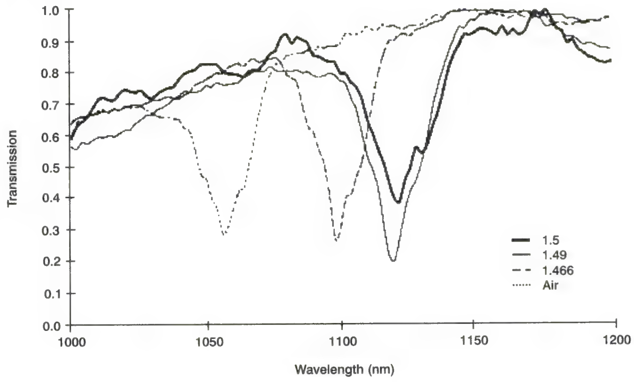


Figure 10 Wavelength dependent transmission from a liquid crystal cell coupled to a planar waveguide. Courtesy Dr Iain Mauchline OptoSci Limited.



anywhere between 240° to 270° gives better switching and makes them suitable for both notebooks and more recently mobile phones.

In terms of size LCDs can be divided into three categories - small, (less than 6in diameter) usually for telecommunications and handheld applications such as organisers; medium (6-14in) for applications such as laptop computers and large (greater than 14in) for desktops and TV sets. Small displays generally only require passive-matrix technology and must be low cost. However, the advent of 3G mobile phones and future 4G phones with their emphasis on information accessibility will probably change all this.

The Future and Beyond?

Finally a few ideas and likely possibilities for the future include windows or panels hung like paintings, which can be transformed into a backlit screen revealing beautiful pastoral images (or whatever you choose to see!) Such A3/A4 or even larger future displays could be controlled with software algorithms that could generate interesting and constantly evolving pictures. Imagine the Hay Wain by Constable going through Spring to Winter with activities taking place in the background from planting through to Harvest! Liquid crystal Heads Up Displays (HUD) will probably have widespread applications in virtual reality for fully interactive 3D virtual reality experiences. Philips have developed a multi-view 3D LCD. By adding a specially designed lens to the front of a high quality in-house designed LCD and using specially designed image processing software also developed by Philips Research, the display allows the viewer to see a 3D image without the need for special glasses (see Figure 11). Advanced computer software systems could even be combined with sound to help in teaching a variety of subjects, for example the history of an English town from the Roman period right up to modern times by giving immersion in historical scenarios.

There is certainly little doubt that LCD manufacturers are having a boom time with the explosion in demand for cellular phone displays. It is widely anticipated that production of LCDs for mobile phones will overtake notebook PCs by the end of 2000. In 2000 LCD sales for mobiles may be as high as 830M$ US compared with approximately 800 $M US for notebooks. However, notebook sales are still growing significantly year on year. One suggestion for both military and civilian displays applications is to provide head visor or 'see through' glasses displays where a variety of different types of information can be displayed more comfortably to the human operator. This information could be E-Mail, data, a high quality video-link image, and even ordnance survey map information. However, getting good viewing under a wide variety of illumination conditions and several decades of intensity is quiet a difficult challenge to achieve. Liquid Crystal Displays have truly revolutionised the portable instrument/computer/communications market in the last 2 decades and technological challenges for future applications offer a promising future for this now maturing technology.

Further information:

Motion Media videophone conferencing.
`www.motion-media.com`
Philips Research
`www.research.philips.com/password`
Dr T Kallfass University of Stuttgart, Germany.
Crystaloid Liquid Crystal Displays, 5282 Hudson Drive, Hudson, OH 44236-3769 USA.

Figure 11 Philips planned 3D LCD display. Courtesy Philips, Holland.

Velleman DIGITAL PANEL METER

John Mosely constructs this versatile, easy-to-build kit from Velleman

This is a very compact and easy-to-build 3-digit panel meter that can be used to replace a conventional analogue moving coil movement, or built into existing or new equipment such as power supplies, digital thermometers etc. The meter comprises of two similar size PCBs, one containing the input and driver electronics, and the other the display. The boards are held together by two long screws with spacers and connecting wire links. The screws are deliberately suppli long to allow fixing to a front panel. The meter requires a stable 5V/250mA DC supply, th accuracy of which will influen the accuracy/stability of the meter. The circuit diagram is shown in Figure 1.

FEATURES

- 5V/250mA DC max. power supply
- Range -99mV to +999mV full scale
- Null setting
- Overrange indication (positive and negative)
- 1mV resolution
- 0.1% linearity
- 100mΩ input impedance
- 20μV/°C temperature drift

Construction

Since there are minimal components, construction is very straightforward. On the component PCB a link has to b inserted near to IC2, followed by the three BC557 (or equivalent) transistors. The single capacitor in then soldered in followed by the tw 16-pin IC sockets (it is importan to check orientation here), followed by the supplied PCB pins for external connections to the power supply and input. Finally, the two preset resistors are mounted and soldered in.

The other PCB holds the three display modules, and again it is important to align th modules correctly. The positio of the decimal point is marked on the PCB. The three resistors (Rx, value 330Ω) are not strictly necessary unless you do wish t provide a decimal point input, and adequate PCB pins are also included for connection to a source.

The boards can now be connected together, using the two screws, 10mm spacers and nuts supplied for this purpose. Ten connecting wires have to be soldered between the two boards. So before the two boards are screwed together it is necessary to ensure that the holes on the boards line up

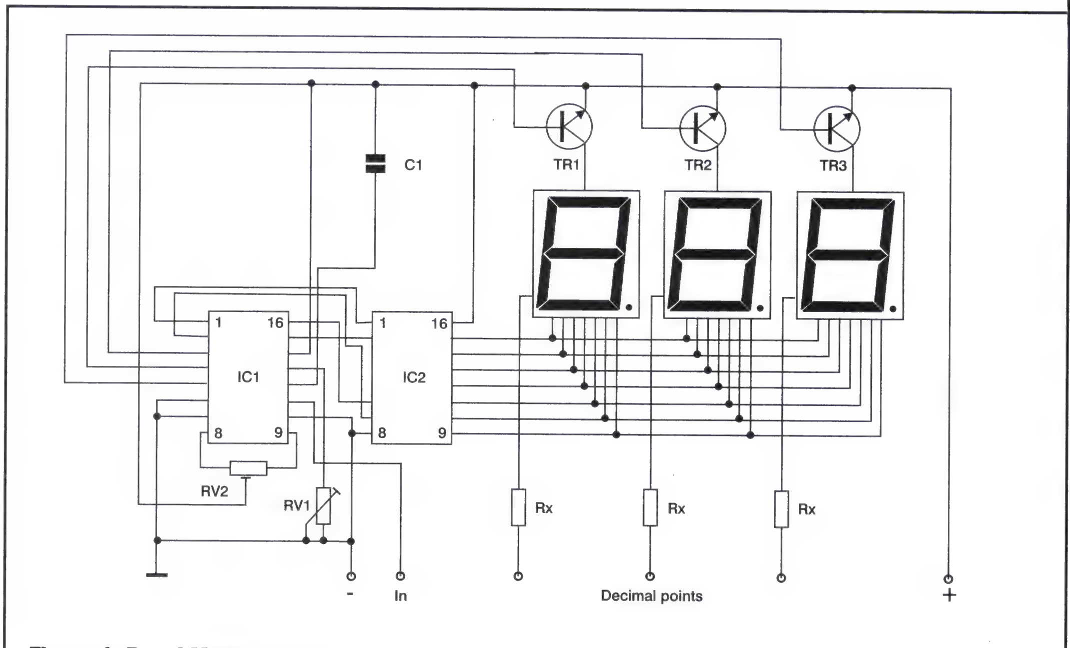
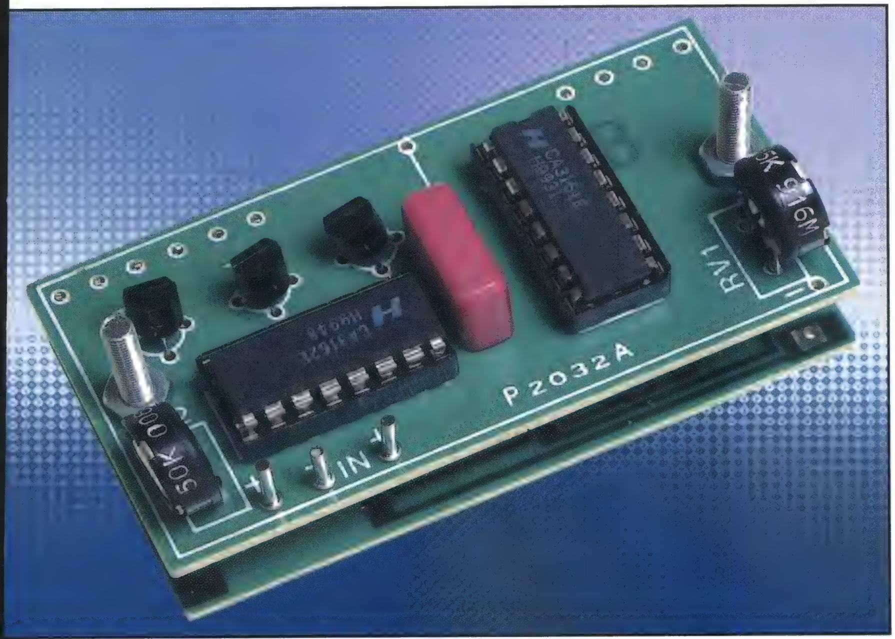


Figure 1. Panel Meter Circuit



PROJECT PARTS LIST

RESISTORS:

Rx	330Ω (optional - 3 required)
RV1	22k vertical preset
RV2	47k vertical preset

CAPACITORS

C1	220nF polyester

SEMICONDUCTORS

IC1	CA3162
IC2	CA3161
TR1,2,3	BC557 or equivalent

MISCELLANEOUS

LED 0.5mm LED display (3 reqd.)
16-pin DIL holder (2 reqd.)
PCB pins

with each other. Note that the boards are joined with the tracks facing each other. The connecting wire is supplied to provide the links, and great care has to be taken when soldering to the boards. I pushed the wires through, soldered and then trimmed both ends. When you are happy with the soldering, the two ICs can be inserted in to their respective holders. We can now test and calibrate the meter.

Set-up

With a stabilised +5V DC (250mA) applied to the board and the input terminals shorted, you should see on the display a value near to '000.' Adjust RV1 for a zero reading. Now apply a known 999mV DC supply to the input pins - I used a variable DC supply with digital readout and a digital multimeter to set this value. Now adjust RV2 so that the display reads 999mV, and that's it. I check 30 minutes later and the display was still reading correctly, and required no further adjustment.

Conclusion

Another fine kit from Velleman that can easily be incorporated into a range of test, or similar equipment.

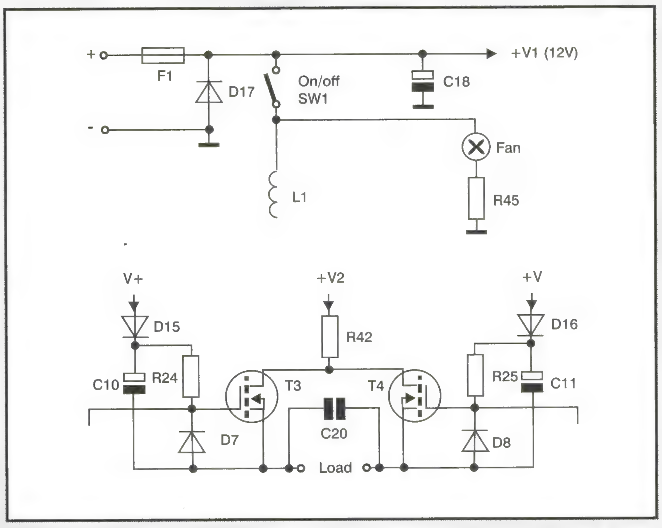
Maplin order code: VE60Q
Price £24.99

ELECTRONICS CORRIGENDA

July 2000/Issue 151
Velleman 250W 12V DC/230V AC Converter
Page 9

There were two unfortunate errors in the diagram shown on page 9 of issue 151. Diode 17 is the wrong way round and the voltage to the top end of R42 is +V2. The corrected parts of the diagram are reproduced here.

In the text it is outputs Q4 and Q5 of IC2 that are Ored together. Also it is important that suitable mains cable is used for the output, with a suitable socket. This cable should pass through the grommet and internally 'tie wrapped' with the supplied tie-wrap. The usual precautions must be followed when dealing with mains, and mains appliances. We apologise for these errors.



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Easy Web Page CREATION

- Further Reading

Mike Holmes brings his recent series up to date.

Dynamic Documents - Scripts and Applets

The basic HTML specification, examples for the application of which I have attempted to illustrate in the foregoing series Easy Web-Page Creation, has, not unexpectedly, evolved a good deal in just a few short years, such that already the latest iteration has reached version 6.0.

This is because, since the very beginning, Web enthusiasts quickly concluded that the content supported by the Web's basic HTML document format was too limited. HTML extensions, such as forms and frames, and the addition of cascading style sheets that allow proper typesetting protocols to be applied to pages, only served to highlight those limitations while at the same time making it clear that no single browser could include all the features users wanted.

Yet more extensibility was desired, but without making the basic HTML code structure too unwieldy, so as a result pages acquired executable program code, in the form of scripts and/or applets, becoming dynamic documents. This has been eagerly adopted by all and sundry such that as time goes on the instances of scripted pages are fast becoming manifold. It is highly probable that of all the pages you download from the Web at the moment, 50% of them are quite likely to include some sort of dynamic script.

This has created 'pressure' on the client platform to upgrade browser software just to keep up with the latest innovations. Versions 4 of both Microsoft Internet Explorer™ and Netscape Navigator™ have already become the minimum level necessary if the user is not to miss out on all of the rapidly increasing variety of special features that are quickly becoming commonplace.

Most importantly, these browsers introduce two significant new features - in Explorer, an element called <SPAN>, and for Netscape, a device called a 'layer'. In a nutshell, each allows the author to put images or text anywhere on the page, even over the top of the normal page content, where hitherto the layout of items was restricted to side-by-side on the page.

Page Scripting

Of increasing significance, therefore, is the use of scripts. As a consequence, Web sites that don't exploit this feature are beginning to look bland by comparison.

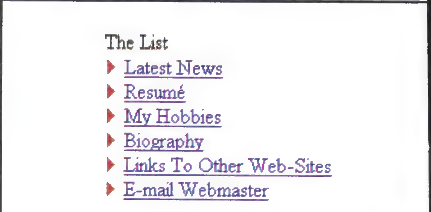
Script is executable code, written in a programming language, and which is compiled on loading then executed by a script-aware browser. JavaScript and Visual Basic Script (VBScript) are the commonest. Unfortunately, VBScript is only supported by Microsoft Internet Explorer™ version 3.0 or greater; however, for more detailed information and a complete downloadable HTML help reference page set, go to: `http://www.microsoft.com/vbscript/`

JavaScript

This leaves JavaScript, developed by Netscape from Java (see later), and supported by Navigator version 2.0 upwards and Internet Explorer 3.0 on (at least), and which therefore has become practically universal. With a script, a Web page becomes a mini-program, able to do things like conditionally load other pages, open and close browser windows, get user input, check forms for correct content before mailing; animate images, encrypt credit card numbers, write completely new documents from scratch (as a typical example, a final 'shopping list' form made up from choices from an online catalogue), or even rewrite itself.

With no familiarity beforehand with Java-like code, the syntax of JavaScript can be quite strange, especially for anyone hitherto only used to BASIC. I was going to include a resumé about it here, but there were too many words. So instead I refer you to the equivalent document: `http://www.mc-h.demon.co.uk/maplin/aboutjava.html` for an introduction to JavaScript syntax. For more information and examples, go to Netcape's Web-site: `http://home.netscape.com`. You are also recommended to download and un-ZIP their HTML help page set: `http://developer.netscape.com/docs/manuals/communicator/jsref/jsref.zip`, a hefty tome describing all aspects of the language as used in Netscape versions 2.0 through 4.0, and which apply equally to comparable versions of Internet Explorer.

A Dynamic Menu



The List
- ▸ Latest News
- ▸ Resumé
- ▸ My Hobbies
- ▸ Biography
- ▸ Links To Other Web-Sites
- ▸ E-mail Webmaster

Figure 1. Menu of anchor links with animated arrows before styles are applied.

So what we'll do now is look at a couple of worked examples of pages that use script t animate some images, which gives an idea of how such techniques can be made to work. Note that without the script, the pages should still function as normal and s remain 'downwardly compatible' with early (non-script-aware) browsers.

Figure 1 shows a simple menu of hyperlinks to some other pages, appearing in the 'raw' style determined by the default settings of the browser. By itself it looks a bit lack-lustre aside from some arrowhead images by each option. The object of the exercise is to make each arrow change colour when the mousepointer passes over its associated anchor text.

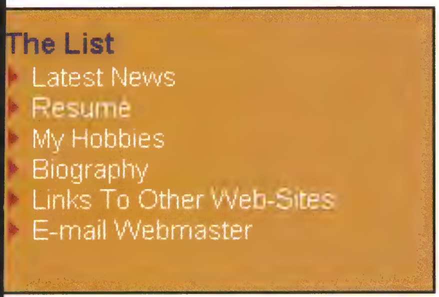
Before that, however, we ought to improve the page's appearance and, increasingly, this is now done by applying styles, because styles allow more detailed control over appearance than conventional element attributes. Here we can group all the styles we want in a <STYLE> element added to the <HEAD> section as follows:

```
<!DOCTYPE HTML PUBLIC "-//SQ//DTD
HTML 2.0 + all extensions//EN">
<HTML>
<HEAD>
<META NAME=”Description”
CONTENT=”script driven image
switching”>
<TITLE>Hyperlink Menu</TITLE>
<STYLE TYPE=”text/css”>
body {font-family:Arial, Helvetica, Univers;
font-size:11pt; text-decoration:none;
background-color:peru;}
.hltitle {font-family:Arial, Helvetica, Univers;
font-size:12pt; color:darkblue; font-
weight:bold;}
.hlitem {margin-left:14px; text-indent:-
14px;}
...
</STYLE>
```

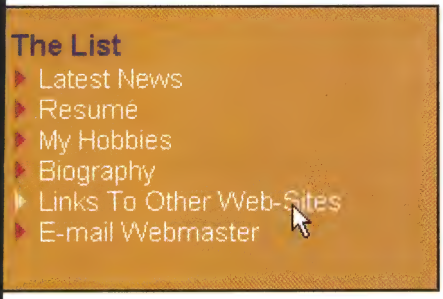
The first forces a default sans-serif font of 11 points on all text on the page, that is, contained by the body element, except where specified otherwise. For instance, the second is a custom style, applied to a <DIV> element containing the sub-title:

```
<DIV CLASS=”hltitle”>The
List<BR></DIV>
```

(See also `http://www.mc-h.demon.uk/maplin/named_colours.htm` about named colour codes.) Similarly, the image/anchor pair of each hyperlink is enclosed in a division having a 'CLASS=”hlitem”', to which a hanging indent is applied:



igure 2. a: Anchor links menu with display odified by styles; b: arrow heads change hen mouse pointer passes over each em.



```
  <DIV CLASS="hlitem"><IMG
RC="../images/iarrow_nr.gif"
ORDER="0" WIDTH="11"
EIGHT="11">
  <A HREF="../unavailable.html">Latest
ews
  </A><BR></DIV>
```

There are also other styles that affect how he anchors are displayed, and the result is hown in Figure 2a. The effected anchor hat currently has the mousepointer over it s indicated by its associated arrow image lighting up' (turning pink), and returning o normal (dark red) when the mouse eaves, as in Figure 2b. How is this done?

mage Swapping Script

This example exists as a real page at: **http://www.mc-h.demon.co.uk/maplin/dynamic_img1.html**, which your browser can save a copy of to examine in more detail. You will find that following the <STYLE> section in the document header, there is a <SCRIPT> section, and it is this that causes the arrows to flash on and off.

I am only going to cover the essential points here - to access the complete HTML page and script, see the above URL. The script begins:

```
<SCRIPT LANGUAGE="JavaScript"><!—
```

and the first item is:

```
var imagesOK = false;
```

This is a boolean flag that will be used to determine whether the browser has loaded all the images that will be needed. Without it the situation could easily develop where an image swapping function is trying to assign a different image to an IMG element, but cannot because it is not loaded yet. This can occur where it just so happens that the mousepointer position exactly coincides with one of the anchors when the page first appears, but before it has finished loading all its images, and this is quite likely to raise a script run-time error. The idea is that while 'imagesOK' is false, the script does not try to swap an image.

The next two items will become global storages where the two alternative pictures will be held:

```
var ArrowOn = null;
var ArrowOff = null;
```

They are 'null' ('nothing') for now, but are put here in the 'root' level of the script so that they are permanently available for as long as the page persists in the browser. This is because the actual initialisation will be done by a function, but if these variables were created inside the function they would be destroyed as soon as it ends.

The function that sets up these images is called by the body onload event, as in: '<BODY ONLOAD="setupImages()">'. This is necessary to make sure that the page and all its elements have completed loading first. This done, the function will then create the two alternative image sources that will be used to change the image elements on the page:

```
function setupImages () {
  if (document.images.length) {
```

It is prudent to make sure that the page actually has pictures to swap, otherwise there is no point in going on. This is done by checking the length of the images array. Because JavaScript is an object-oriented language, it turns out that many aspects of the browser can be accessed as objects, and that furthermore some of these do themselves contain other objects, and, of course, have properties.

Therefore, as can be seen in the simple heirarchical tree of Figure 3 (there is a complete version in Netscape's JavaScript help), the document is a child of window, which is at least a child of the browser (else a frame in a frameset). Furthermore, document is a parent of several other types as shown. Because there is often more than one instance of each type, and which need not be named individually to distinguish them, it is necessary for the browser to hold them in a number of arrays; each separate item can therefore be identified by its index in the array. Hence you have an array of anchors, an array of forms, an array of applets, etc., and, of course, an array of images.

Thus, in the foregoing statement, length is a property of the images array, which is a child of document. (You could go deeper than this and write 'window.document.images.length' or 'self.document.images.length'.) If length is zero, the page has no pictures on it, and this is implied in the expression; it is false if length is zero (more properly it could have been written 'if (document.images.length > 0)').

If the page has pictures (length > 0 = true), the following statements are executed:

```
ArrowOff = new Image();
```

Without going into this in too much detail, JavaScript has a number of built-in object constructor functions that you can use to create new objects in code (there is a complete summary of this in the Netscape help). One of these is image, although of course none of them are visible on screen, they merely duplicate all the properties and methods of the equivalent visible object of that type.

One of the properties that an image, like IMG, has is SRC, the URL of the picture file. So now we can do this:

```
ArrowOff.src = "../images/iarrow_nr.gif";
ArrowOn = new Image();
ArrowOn.src = "../images/iarrow_sr.gif";
```

We now have both the pictures that we need to achieve the desired effect stored locally in new image objects. This is important because as it stands, no HTML code on the page asks for the 'active' or 'switched on' arrow picture to be downloaded, only the 'off' picture. It is no good swapping to a different image only to discover that it then needs to be downloaded from the site - apart from the possible time delay, suppose the browser went off-line before that time? This method makes sure that the browser has downloaded all the images it needs to perform the necessary actions, before they are required. This means that finally:

```
    imagesOK = true;
  } // (end of 'if')
} // (end of function)
```

we can enable the flag that informs the actual doing part of it that it can now do it.

Script And HTML

This next stage requires HTML to integrate with the script. Again taking the first item as an example, comprising an arrow picture and an anchor, we modify it as follows:

```
<DIV CLASS="hlitem"><IMG
SRC="../images/iarrow_nr.gif"
BORDER="0" WIDTH="11" HEIGHT="11"
ID="hl1" NAME="hl1">
<A HREF="../unavailable.html"
ONMOUSEOVER="GotFocus (hl1)"
ONMOUSEOUT="LostFocus (hl1)">Latest
News</A><BR></DIV>
```

All these divisions are basically the same, except that each picture now has a unique NAME, in this case, 'hl1' (hyperlink 1) for the first item. (Note that to be on the safe side, make the ID attribute the same for the benefit of Internet Explorer - often it only recognises a named object through the ID.)

The only other addition to the hitherto conventional HTML is to the anchor element - two events, ONMOUSEOVER and

```
browser
   |
   +--- window
           |
           +----------- document
           |               |
           +--- location   +--- layer (Netscape only)
           |               +--- link
           +--- frame      +--- image
           |               +--- area
           +--- history    +--- anchor
                           +--- applet
                           +--- plugin (Netscape only)
                           +--- form
```

Figure 3. Where the document and its components lie in the heirarchy of browser objects.

ONMOUSEOUT. These call one of two functions as appropriate, 'GotFocus()' and 'LostFocus()', passing the unique name of the associated image. Note, however, that here the name is not enclosed in quotes, therefore the function's parameter actually receives a direct reference to the image as an object:

```
function GotFocus(imgname) {
  if (imagesOK) imgname.src =
ArrowOn.src;
}
```

Which means the SRC property can be applied directly to it, and which of course comes from our stored copy, 'ArrowOn'. Voila, the visible picture is changed. Not unnaturally, 'LostFocus()' is virtually the same, but does it the other way around, using 'ArrowOff' as its source. Note also that neither will do anything if 'imagesOK' is false.

Pursuing A Trend

Figure 4a illustrates a much more sophisticated extension of this theme. It is very common for commercial Web-sites, and is increasingly appearing on private ones. It is based on the idea that there are a series of images that are obviously clicked on, each with their own unique caption. Variations include buttons or image areas that change colour, or adopt a 3D beveled edge, or have text that is normally blurred or 'wind-swept', but which is sharpened (made clearer) when the mousepointer is positioned over it.

In Figure 4a, and in addition to an arbitrary image at top left representing a logo, there are a number of lozenge shaped buttons in 3D style, each with its own special caption. These have been developed in a suitable image editor, starting with a template, and something of how this was evolved is indicated in Figure 4b.

Having a series of unique images - unlike sharing common ones as was the case in the example of Figure 2 - adds some technical complexity to the process of image-swapping. The desired effect is that when the mousepointer passes over any button it should 'light up', as though there was a bulb behind it, as shown in Figure 5. This means that each button must be represented by a pair of images with the same caption, one for 'on' (bright) and one for 'off' (dull), so actually twelve separate pictures are needed, not merely the six visible on the page.

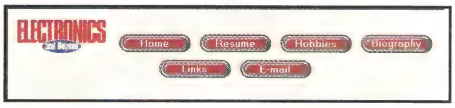
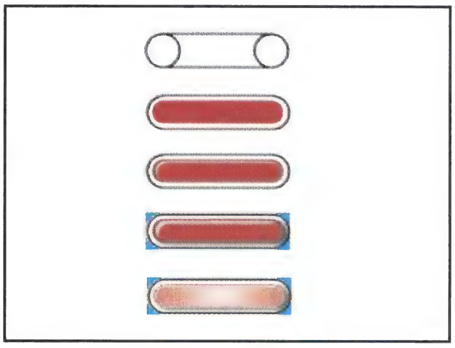


Figure 4. a: A menu having a group of unique 'buttons'; b: how the basic template for each image was evolved.



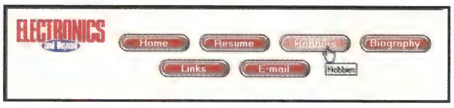


Figure 5. Each 'button' is illuminated when the mousepointer moves onto it.

Using Arrays

Manipulating all these images by name in code is possible but can become unwieldy and inefficient, especially if they are moved about or extra ones added, or some removed. It makes more sense, therefore, to exploit the fact that the document stores these buttons in an images array, and one of the other object types you can create in JavaScript is the array.

Again this page exists at: http://**www.mc-h.demon.co.uk/maplin/dynamic_img2.html** which you can save off and study in more detail, so only the more relevant features will be mentioned here. Primarily, this involves storing the 'on' and 'off' button image pairs in parallel arrays. This is done as follows - these are created at the script 'root' level:

```
var imagesOK = false;
var inactive = null, active = null;
```

In the 'setupImages' function, two lists of image URLs are prepared in temporary arrays, as these are easy to edit if required:

```
var inactivenames = new
Array('images/btnoff1.gif',
'images/btnoff2.gif', ... etc.);
var activenames = new
Array('images/btnon1.gif',
'images/btnon2.gif', ... etc.);
```

Once used, these will no longer be required and are discarded when the function ends. However, the next important stage is to turn the two global storage variables into arrays to hold all the images required:

```
inactive = new Array(inactivenames.length),
active = new Array(activenames.length);
```

In this variation of the assignment, the arrays are dimensioned to the number of names, as opposed to providing a set of data items. Then a for - next loop is used to physically collect the pairs of image files from the domain:

```
for (var i = 0; i < inactivenames.length;
i++) {
  inactive[i] = new Image();
  inactive[i].src = inactivenames[i];
  active[i] = new Image();
  active[i].src = activenames[i];
}
```

There are two things to note here. Firstly, a further object can be assigned to an array element (here, a new image type), and secondly, from here on the images are only identifiable by their indices. Hence, inactive[0 - 5] are the 'off' buttons, and active[0 - 5] are the 'on' buttons. This keep the 'gotFocus' and 'lostFocus' functions simple:

```
function gotFocus (imageid, index) {
  if (imagesOK)
document.images[imageid].src =
active[index].src;
}
```

where imageid is the index of the document's own images array, and index is the number of the alternative in the named storage array. The calling code for each anchor is therefore 'ONMOUSEOVER="gotFocus(1, 0)', and so on.

Troubleshooting

Whilst Internet Explorer is probably more popular than most, this author recommend that you obtain a copy of Netscape Navigator as an aid in debugging your scripts. This is because Netscape is somewhat more fussy about script syntax and its application than is Explorer, since the latter has the ability to resolve the odd small problem by itself without you being aware that there were any!

Navigator version 4.0 is preferable as this generates proper error messages (curiously, the current beta version 4.6 does not, just a really quite useless status-bar message). It may be provided on one of the many free Internet access CD's, or you can obtain a free download from **http://www.netscape.com.**

Anomalies in the interpretation of script between the two browsers do exist - one such is Netscape's inability to recognise the 'substr' method of a string - despite being cited in Netscape's own JavaScript help! Another is a confusion that arises in rare circumstances over the length property of a string - for example, 'alert (mystring.length)' displays 'undefined' or 'NaN' (Not a Number).

One possible cause is where the string was taken from an externally accessible property of an applet; it is supposed to be a string but Netscape is not quite sure. The cure is to force it to be treated as a string type by adding empty text: 'alert (''+mystring.length), which works. On the other hand, and as you might expect, Internet Explorer has no problem with either of these occurrences.

A Brief Mention Of Java

JavaScript is, of course, based on Java. Originally called 'Oak', Java was a form of 'simplified C' designed for use in embedded consumer-electronic applications. After some years, however, it was retargeted to the Internet and renamed Java. The story behind this choice of name was that Sun were not about to call their new Internet language, based on C, 'D', but were still stuck for a suitable name. ('Oak' wasn't attractive.) Finally, at a specially convened (and, I suspect, rather desperate) 'name choosing' meeting, and because the participants were drinking coffee at the time, it was eventually named after the Java coffee bean. It's a true story, folks!

ava Support and pplets

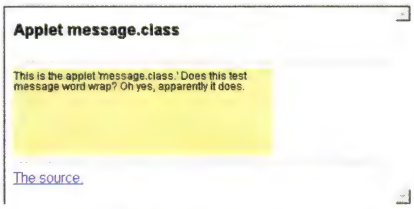
va is a programming environment that perates in conjunction with Java aware rowsers to allow you to embed a separate rogram, called an applet - literally, a 'little pplication' - into an HTML document.

Applets are not part of the HTML 2.0 pecification, and are therefore not upported by very early Web browsers. herefore, you ought to include alternative xt and applet-internal block elements efined for non-applet aware browsers.

Writing your own applets is very ewarding, when it works. Being written in va, of course, the task is quite difficult to et your head around if you have had no xperience of C. This is exacerbated by Sun ystem's attitude to providing suitable help exts for when it comes down to the nitty-ritty they keep referring you to books bout C!

However, what information there is you an find at: **`http://java.sun.com/`.** There re two things to bear in mind about Java - rstly, and quite unlike JavaScript, Java is strongly typed" (which does not mean that ou press the keyboard keys especially ard!). What this means is that variables, for xample, are explicitly defined as integer, oat, string, char, byte, etc. types, and it is ot always easy to transfer the data of one ype to another.

On the other hand, you should find that many methods have been provided to do most of these things for you, so before rying to figure out how to turn a URL type, alled 'u', into ordinary string form 's', for xample, look to see whether a method lready exists for it (in this case, 's = .toExternalForm()'). Beginners are advised o get the hang of JavaScript before tackling ure Java.

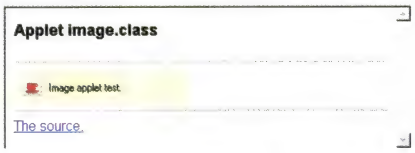


Applet message.class

This is the applet 'message.class.' Does this test message word wrap? Oh yes, apparently it does.

The source.

Figure 6. An applet that automatically word-wraps it text caption.



Applet image.class

Image applet test

The source.

Figure 7. An applet that displays both an image and text.

Creating Your Own Applets

If you want to get into making your own applets I recommend the following two packages, both free. The first is Sun's Java Development Kit (JDK), which you can get from: **`http://java.sun.com/products/jdk/1.1/`**. It includes a compiler and everything else but is actually a little awkward to use, because it is, for some obscure reason, entirely DOS based.

However, it does have two redeeming features - one is a good number of finished examples, with of course source code, some of which you can use immediately as they stand to display images or play sounds (of particular note is the 'Animator' applet). The second is a complete source code library of all the applets and components that comprise the standardised Java run-time engine, the very same that every Java-aware browser is provided with by Sun.

As in the compiled product, this is organised into sections, called 'packages', spanning a number of disk directories. Interestingly the compiled version is contained in one large ZIP file incorporating the same paths; in use the browser's Java compiler extracts the relevant components directly from a ZIP just like this (or it used to be the case). Therefore, where you see a piece of applet code using a component from the engine, you can trace it right back to its source to find out what exactly what it is doing.

Especially recommended for newcomers, however, and particularly if you want to stay in the Windows environment, is Microsoft's free trial version of Visual J++, which you can get from: **`http://www.microsoft.com/visualj/`**. Apart from anything else it gathers Sun System's own help texts into one easily accessible source, which is also context sensitive so that you can get an instant description for all the standard Java components and functions on the screen. Better yet, it is not 'time-bombed' either (well, mine isn't).

Its best feature must be the applet wizard - this asks basic questions about what sort of applet you want, approximately based on the sort of thing you want it to do, then all the input parameters that will be supplied by the HTML <PARAM> elements. The result is a basic source code 'shell' that is then developed to form the completed applet, also a test HTML page so that you can try the thing out in your browser as you go along.

Figures 5 and 6 are applets I made with the wizard. Figure 6 is an experiment to find out how to confine a text message to the applet's background by automatic word-wrapping. It borrows directly from an example in the JDK by using the 'FontMetrics' and 'StringTokenizer' components from the Java engine to measure the width of each word and determine where to break lines. Originally called 'message', this applet was tidied up to form 'template', a basis for producing further similar applets, and a demonstation of which is at: **`http://www.mc-h.demon.co.uk/maplin/template/template.html`**, from which you can also get the source code.

Similarly, that of Figure 6 has the basic requirements for displaying a picture, in this case a simple icon. This demonstration can be seen at: **`http://www.mc-h.demon.co.uk/maplin/image/image.html`**. The source code forms the basis for other applets required to display an image, with or without text. Full descriptions of these and two other home-made applets, with demonstrations and source code, can be seen beginning with: **`http://www.mc-h.demon.co.uk/maplin/tree.html`.** This 'tree' page illustrates the heirarchical structure of Java, where components are invariably extensions of foregoing 'ancestors'. These pages were created by the documentation generator that is supplied in the JDK.

For more information about how to insert an applet into an HTML document, and a mention of ActiveX, see the latter part of the reference document at: **`http://www.mc-h.demon.co.uk/maplin/aboutjava.html`.**

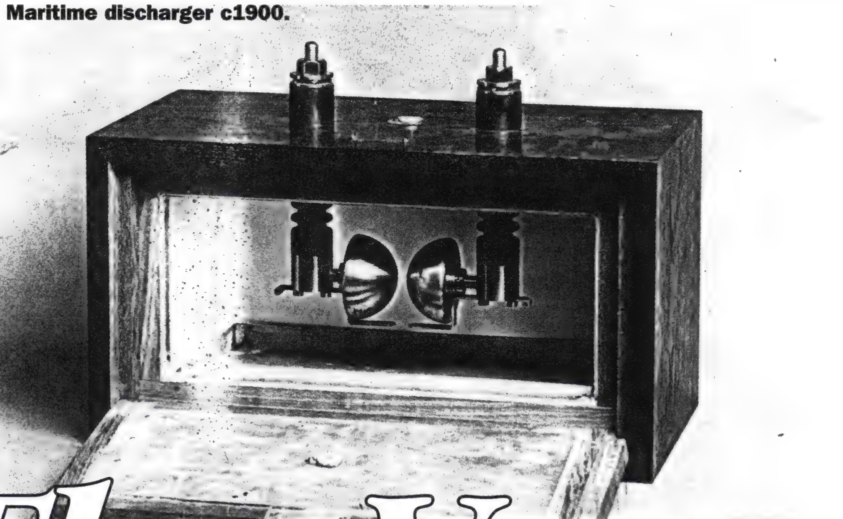
http://www.maplin.co.uk

Interactive Internet Site - On Line Catalogue

Visit the new updated Maplin Website which has been re-designed to make finding products and on line ordering much easier. Visit our new products or our promotion sections for current bargains. Our 20,000 products cover an extensive range of electronic products and accessories, that is accessible and viewable.

you're just a click away

Photo 'C'. Maritime discharger c1900.



The Very LONG WAVES

PART 4

In part 4, George Pickworth looks at the high power spark and arc transmitters of the early 20th Century

In this part of the study we look at spark and arc type transmitters employed by the very long wave superstations from 1906 to the early 1920's. These ingenious devices had power ratings in the order of hundreds of kW and were remarkable feats of technology.

By common usage term transmitter refers, of course, to the high frequency current generator. However, the operation of these early transmitters is still not fully understood. So I decided that it would be easier for readers to gain an insight by progressing in technical stages rather than chronologically. Indeed, both spark and arc transmitters, together with alternators, were developed concurrently. Alternators will be discussed in the following part of this study

The term spark is really a misnomer; an arc is a more appropriate term. Nonetheless the term spark has long been synonymous with wave train systems and the arc with continuous wave systems. I have continued with this tradition but only to differentiate their operating system.

For interests sake I have included Tesla's 1892 diagram that shows virtually all the possible spark and arc oscillator configurations. Readers may like to relate Tesla's diagrams to those in this study see Figure 46.

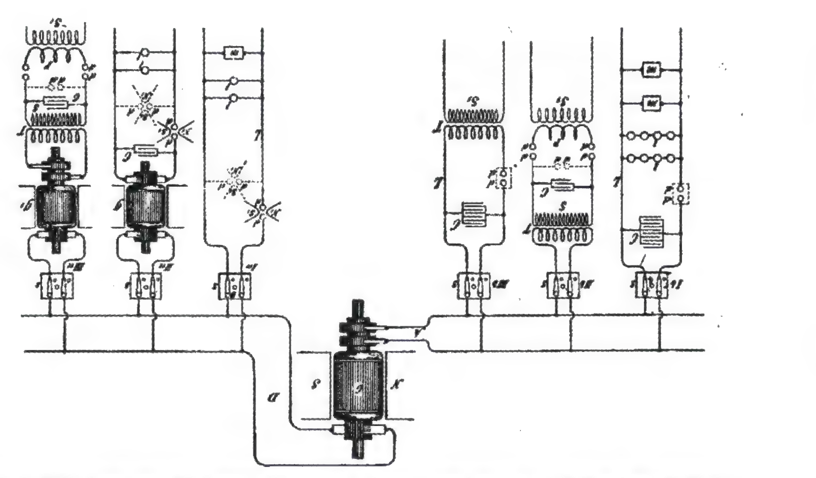


Figure 46. A 892 diagram by Tesla of spark & arc oscillators. On the left are DC powered devices whilst those on the right are AC powered. Readers may like to relate Tesla's diagram to those in this study.

The Discharger - Spark Systems

The heart of all spark systems was their spark gap assembly or discharger, so named because this device suddenly released energy stored in the capacitor.

As the capacitors were charged to a potential in the order of 25kV or more and had capacitance in the range 0.002μF to 0.02μF a large amount of energy was stored But as capacitors have very low internal resistance, a sudden discharge involved a very heavy current.

Early maritime dischargers consisted simply of a pair of metal hemispheres 100 t 150mm diameter inside a sound deadening wooden box with a glass window that allowed the discharge to be observed but filtered out ultra violet light. The hemispheres were attached to screw threads so that gap width could be adjusted Flanges were usually provided to assist cooling, see Photo C.

The use of hemispherical electrodes had its roots in the Righi oscillator where large spheres formed the resonant circuit. But neither spheres nor hemispheres were found necessary with inductance/capacity tuned circuits.

Rotating Discs

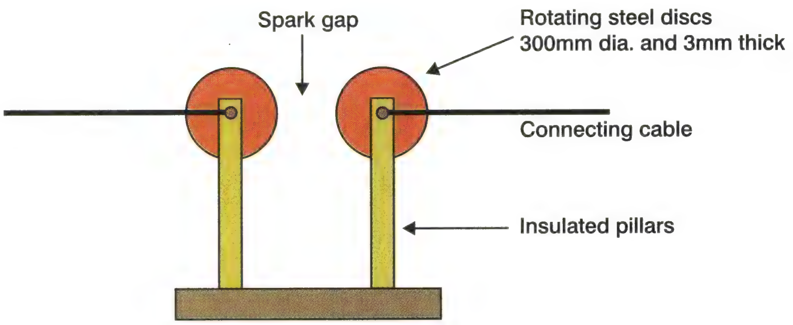
Marconi's approach to high power dischargers was to employ a pair of slowly rotating disc electrodes; discharge occurred from their edges - see Figure 47. The philosophy was that the rotating discs would be self-cooling and erosion would be greatly reduced by continually presenting a cooler surface for discharge. The Poldhu transmitter was first to use a rotating disc discharger.

The original twin disc discharger evolved into the triple disc discharger. It consisted of three steel discs. The main disc, 1.0m diameter between two smaller slowly rotating side discs - see Figure 48. Indeed, it was the development of dischargers capable of handling power in the order of several hundreds of kW that made the superstations a reality.

The triple disc discharger was capable of handling 300kW and with small modifications this versatile discharger was not only the heart of Marconi's Synchronized-Spark wave-train transmitters but remarkably the heart of his Timed-Spark and Quenched-Arc continuous wave transmitters.

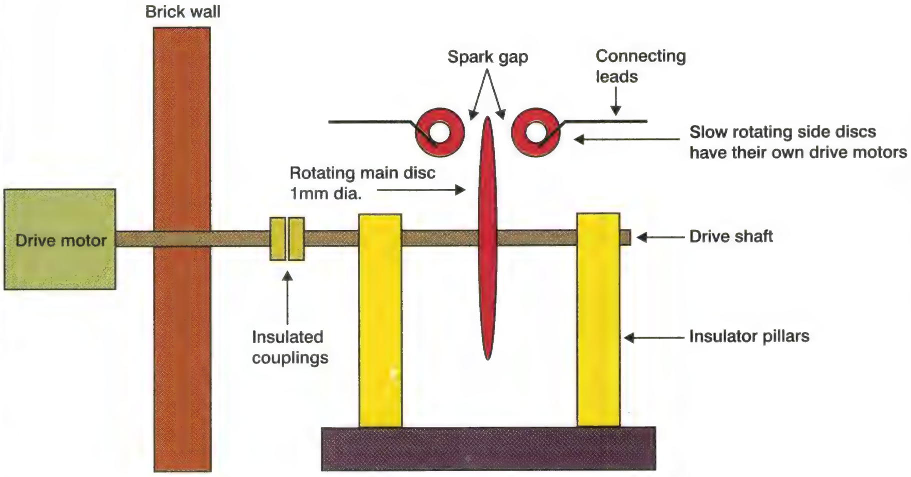
Not surprisingly, because of the high voltages involved and the loud noise they produced, the dischargers were housed on their own in a room having solid brick walls.

Other types of interrupter type dischargers include Prof. Wiens very successful 'quenched gap,' see Figure 52, and Morretti's 'hydrothermic' discharger, see Figure 53. But first let us look at capacitors.



The discs were rotated by an electric motor and worm drive via insulated couplings - compare with Photo C and Figure 48.

Figure 47. Marconi's twin rotating disc discharger used at Poldhu.



This basic design was employed with the synchronised spark, timed spark and quenched arc transmitters

Figure 48. Marconi's triple disc discharger.

Capacitors

As we have seen, energy radiated by a spark type station was first stored in a capacitor. So the dielectric had to be capable of withstanding potentials in the order of 25 - 50kV.

The capacitor of the first Poldhu transmitter consisted of glass plates coated on one side with tinfoil and immersed in oil. Earthenware troughs were used as containers. The philosophy of using oil was that if the glass was punctured by the electric charge, the oil would fill the hole and the capacitor would be self-healing.

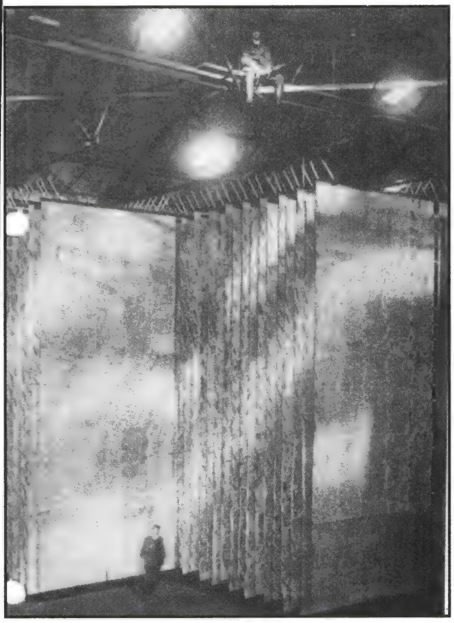


Photo 'E'. Capacitor plates at the Cliftden transmitter 1906.

Unfortunately because of dielectric hysteresis, the glass became very hot and mainly for this reason Marconi employed air dielectric for his Clifden transmitter. However, as the dielectric strength of air is only a fraction of glass, the plates had to be widely spaced. Moreover wider spacing reduced capacity so both the size and number of plates had to be proportionally increased. The result was a capacitor of enormous size - see Photo 'E.'

Meanwhile it was found that flint glass generated the least heat and was therefore used as the dielectric with later capacitors. Moreover, it was found that the glass plates could be reduced to strips or tubes and be used simply as separators, the oil being the principal dielectric; the oil made the capacitor self-healing.

Oil/glass types of capacitors were widely used with high power installations including the Caernarvon transmitter. However, with the Caernarvon transmitter the plates were zinc sheets and wooden boxes replaced the earthenware troughs.

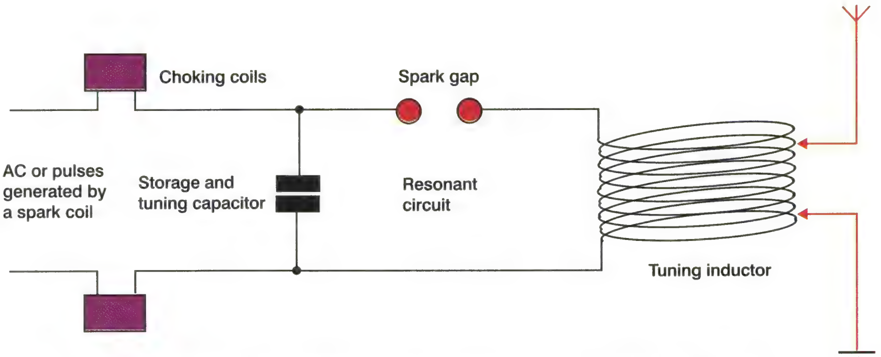
Mica would have been the ideal dielectric and whilst sometimes used with small transmitters, it does not seem to have been used with superstation spark systems.

Direct

As explained in part 3, when a capacitor is suddenly discharged into an inductor it generates a train of oscillations. Remarkably, it was originally thought that energy was radiated by the actual discharge, in fact the discharger is simply a high-speed switch.

With the Poldhu transmitter, the capacitor discharged directly into the inductor that together with the capacitor formed a resonant circuit - see Figure 49. For the sake of a better name I have called this the direct discharge method.

The disadvantage of the direct discharge was that the spark gap was in series with the oscillatory circuit. So, the train of oscillations had to jump the spark gap every half cycle. Moreover, notwithstanding the resistance across the gap falling dramatically as a result of ions persisting in the spark gap, much


Choking coils
Spark gap
AC or pulses generated by a spark coil
Storage and tuning capacitor
Resonant circuit
Tuning inductor

Discharge occurs when the potential of the charge in the capacitor exceeds the dielectric strength of the air within the spark gap. Discharge results in a train of oscillations

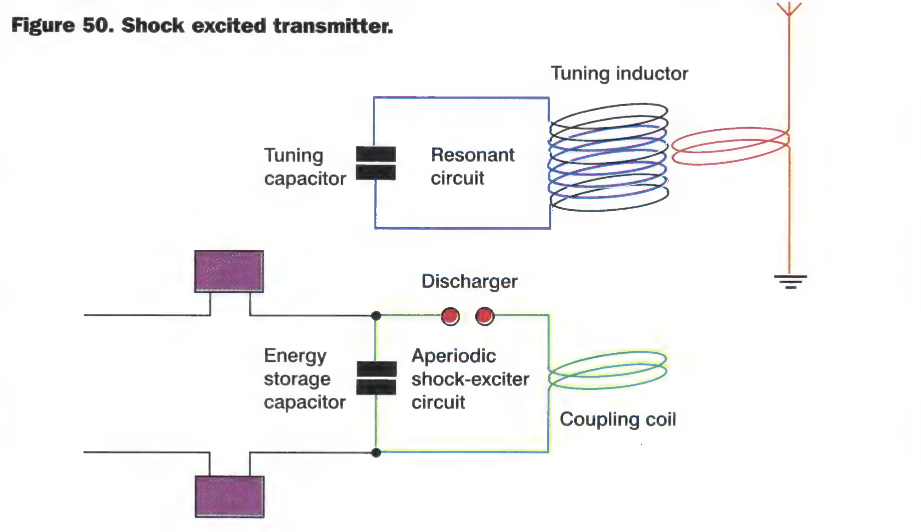
Oscillatory current jumps the spark gap every negative and positive cycle. Losses are therefore appreciable.

As the capacitor stores energy and is also the tuning capacitor, there is a limit to its value if a favourable L/C ratio is to be achieved.

The choking coils isolate the resonant circuit from the power supply.

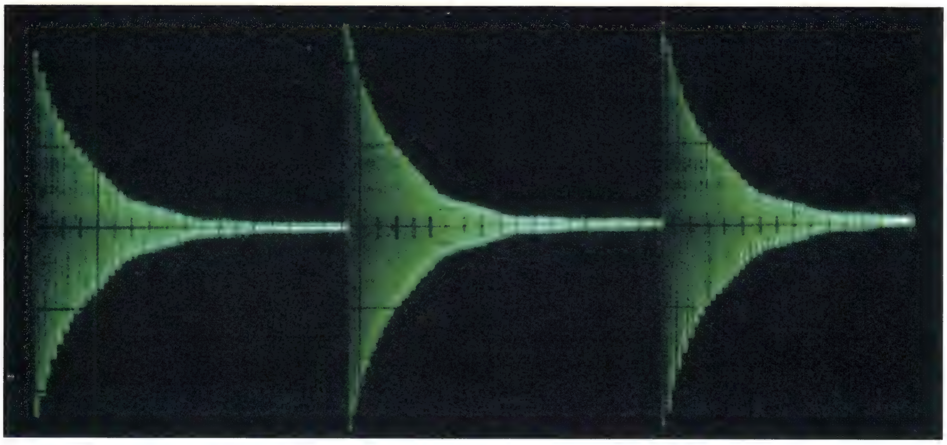
Figure 49. Spark gap in series with resonant circuit - direct system.

Figure 50. Shock excited transmitter.



Losses are avoided by not having the spark gap in th oscillatory circuit. The resonant circuit can have the optimum L/C ratio

The storage capacitor in the shock-exciter circuit can have a large value and therefore store maximum energy. Each discharge shock excites the resonant circuit into oscillation. The discharge breaks the circuit immediately after each discharge thus preventing energy being transferred back to the exciter circuit.



Oscillogram 'D' Wave trains generated by the synchronised spark transmitter.

energy was converted into heat; this was not only wasteful but caused problems with overheating and erosion of the discharger electrodes.

Shock Excited

It was found that losses inherent to direct excitation could be overcome by discharging the capacitor into an aperiodic or primary circuit, inductively coupled to the resonant or secondary circuit. The sudden, very heavy current pulse shock excited the resonant circuit into oscillation see Figure 50

We must now differentiate shock excitation and the tuned transformer system used with Tesla's magnifying transmitter where both the primary and secondary circuits were resonant and tuned to the same frequency. (See part 3)

To take advantage of shock excitation, the primary circuit must be broken immediately after discharge so that energy cannot be transferred back from the secondary circuit; this required an interrupter type discharger. The exciting pulse was therefore a single unidirectional pulse. Marconi's the triple-disc-discharger was readily adapted as an interrupter type discharger.

Synchronised Spark Transmitter

It is easier to understand the operation of the synchronised spark transmitter by first looking at its discharger. The main disc had copper rods inserted around its periphery equal in number to poles on the alternator. See Figure 51.The alternator charged the capacitor via a 25kV step-up transformer.

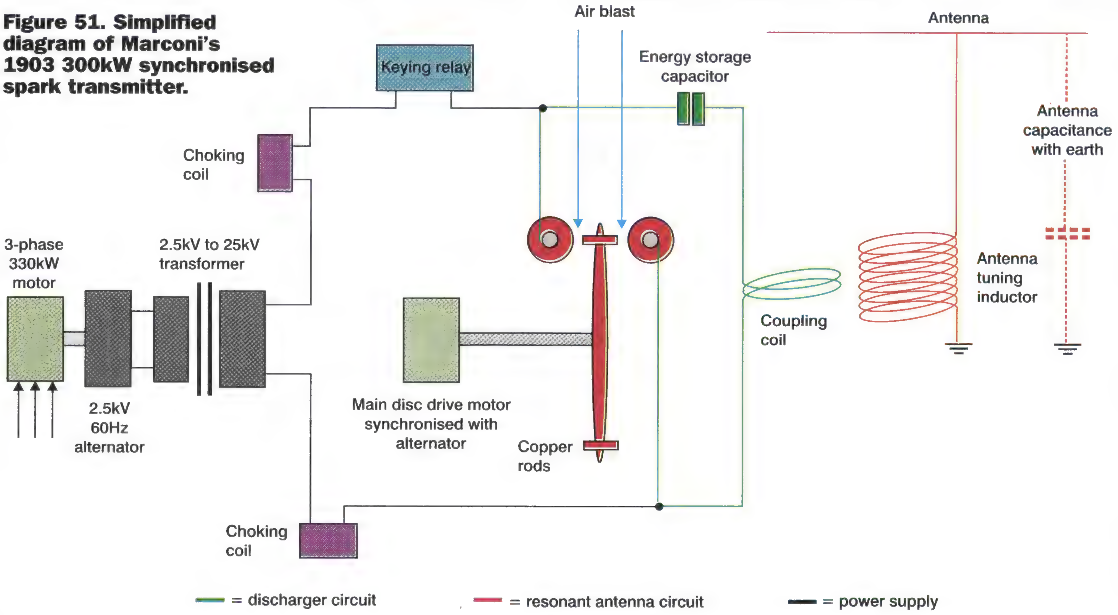
Rotation of the discharger's main disc was synchronised with the alternator (hence its name) so that a rod disc aligned with the two side discs, thereby narrowing the spark gap as the charge in the capacitor approached its peak potential i.e. that of the charging current.

A discharge occurred and a heavy current-pulse was sent through the low impedance primary circuit thereby shock exciting the resonant secondary circuit into oscillation; in this case the resonant circuit was the actual antenna.

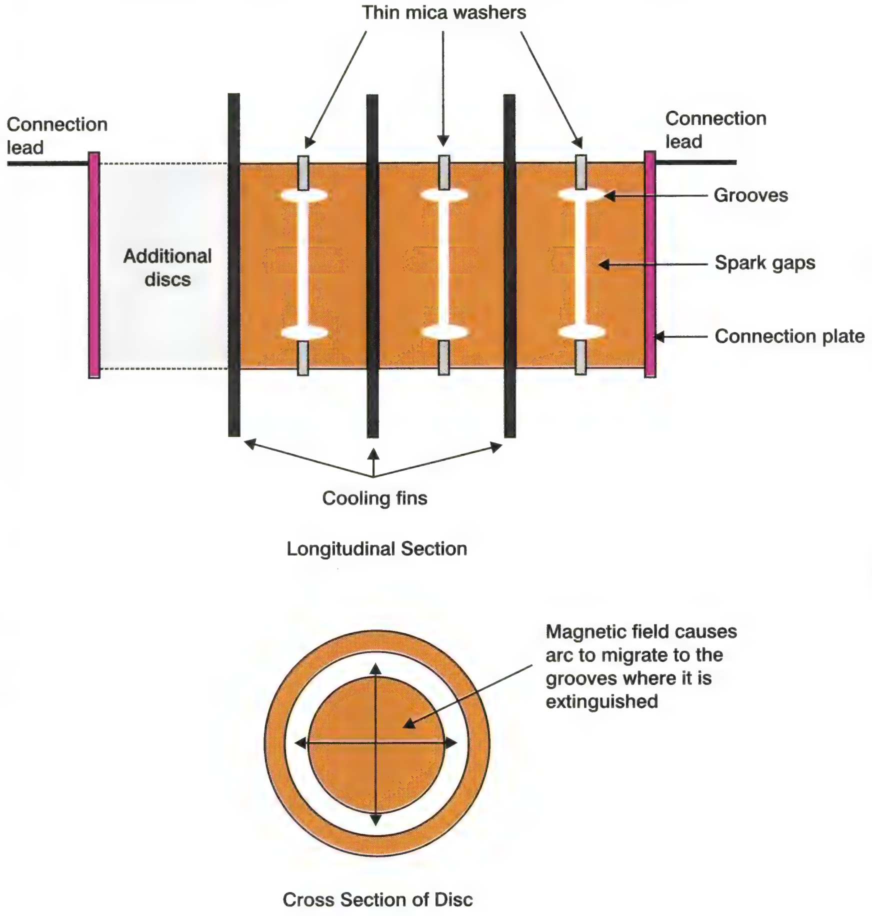
The discharge short-circuited the transformer, so choking coils were employed to limit the current surge and avoid damaging the transformer.

As the main disc continued to rotate, the spark gaps widened and an air blast blew ions

Figure 51. Simplified diagram of Marconi's 1903 300kW synchronised spark transmitter.

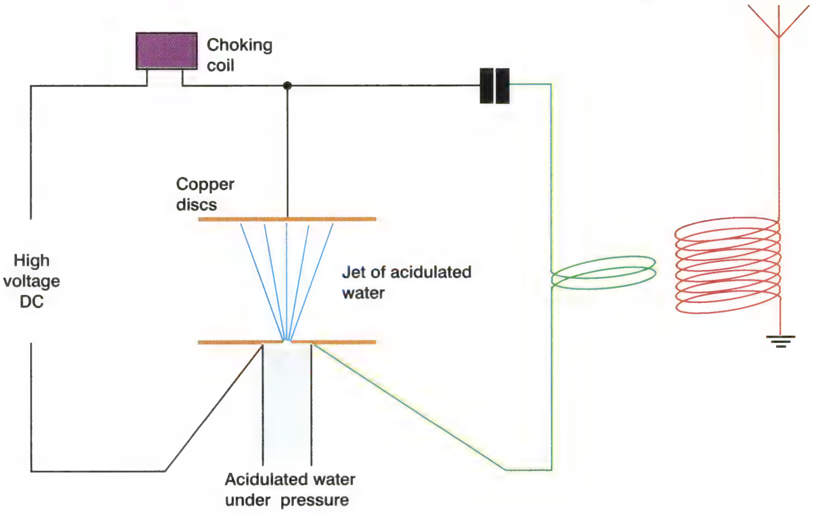


Main discharger disc drive motor is synchronised with the alternator so that a rod aligns with the side discs when the potential of each half cycle of alternator current reaches its peak. Some writers believe that the discharger circuit was resonant at antenna frequency and that the current was oscillatory and energy was transferred to antenna circuit via the coupling coil. The rotating disc, assisted by an air blast, breaks the discharge circuit immediately after discharge, thereby preventing energy being transferred back to excite circuit. The tuning inductor, together with the antenna, forms the resonant circuit. The antenna radiated wave trains with a repetition rate twice that of the alternator frequency, one train for each half cycle i.e. 120 trains/sec.



The discs were very accurately machined to present a perfectly flat and parallel surface

Figure 52. Wien quenched gap.



When the jet of acidulated water impinges on the upper disc, the capacitor discharges through the jet, vapourising it and immediately breaking the circuit.

Figure 53. Morretti's hydrothermic discharger.

away from the gaps thus making the primary an open circuit and precluding re-ignition of the arc by energy transferring back from the secondary circuit. The discharge was therefore mainly current drawn for the capacitor and was essentially a unidirectional pulse.

Meanwhile the capacitor had recharged, the main disc continued to rotate and the next copper rod aligned with the side discs. So, the cycle was repeated .

Antenna Resonance

As we have seen, in part 1, very long wave antennas were a small fraction of a wavelength long, and were therefore poor radiators. The antenna was brought into resonance by its tuning inductor and capacity with earth. The tuning inductor was inductively coupled to the primary circuit. But because the antenna was a poor radiator, oscillations persisted in the antenna circuit long enough to radiate trains of exponentially declining waves.

The alternator delivered current at 150Hz so discharge and therefore wave train repetition rate was 300/second (i.e. one for each negative and positive going half cycle) so a 300Hz tone was heard with rectifier type receivers - see Oscillogram 'D' Detectors will be studied in part 5

In 1914 synchronised spark transmitters were installed at Marconi's Caernarvon, Wales and Wellfleet, Cape Cod USA stations. Both transmitters were rated at 300kW with a maximum antenna current of 220A, and a wavelength of 11,000m. Efficiency from alternator to antenna was given as 30%.

The Caernarvon transmitter was taken over by the Post Office during the First World War, principally for signalling to British navy ships in the North Atlantic (Shades of the German station at Nauen) whilst the Wellfleet station was taken over by the US authorities for security reasons!

Wien Quenched Gap

Space only allows a brief mention of the Wien quenched gap which consisted of a series of discs, each having a groove around their periphery. The magnetic field produced by the discharge caused the arc to migrate outwards to grooves where it was extinguished.

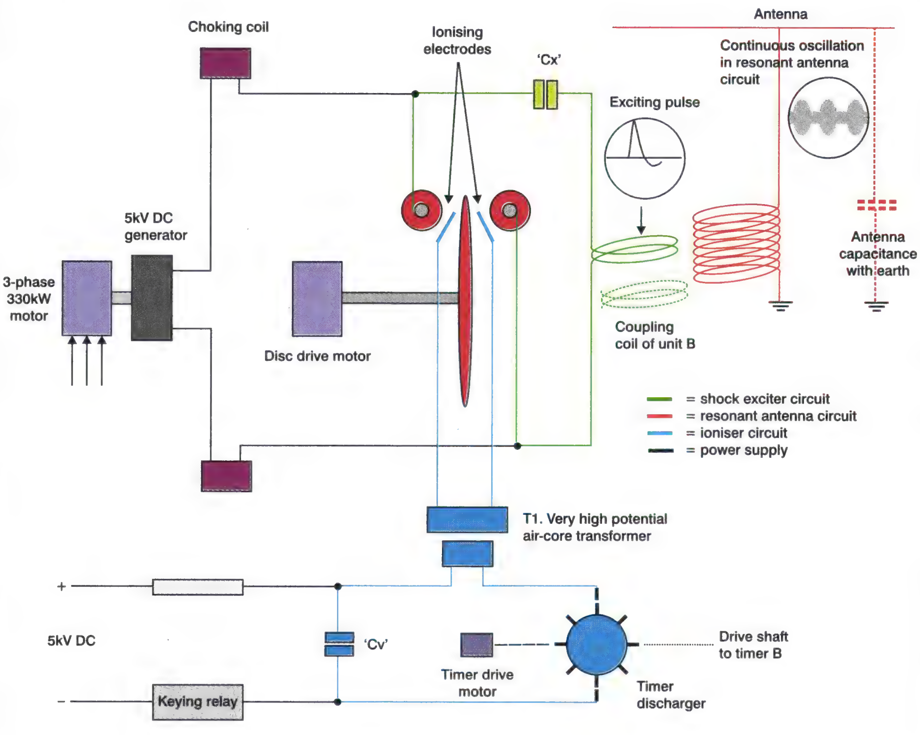
The advantage of the Wein discharger was that any number of discs could be assembled in series thereby making it suitable for use with high power installations. It was employed at the original Nauen and Eilevese superstations, but was superseded by alternator systems. See Figure 52

Morrieti Hydrothermic Discharger

This consisted of a pair of horizontal copper discs located one above the other but with a space in between. The lower disc had a small hole through its centre. Acidulated water was ejected through the hole as a jet that impinged on the underside of the upper disc. See Figure 53

The jet was immediately vaporised when it struck the upper disc, thus breaking the circuit until the jet was re-established. Then the process repeated. The advantage of Morrietti's system was that it was self-cooling and had no moving parts. Moreover, operation was rapid and current pulses were produced in quick succession.

However, by adjustment of the acidulated water pressure, it was reported that the discharger could generate shock exciter pulses capable of producing trains of

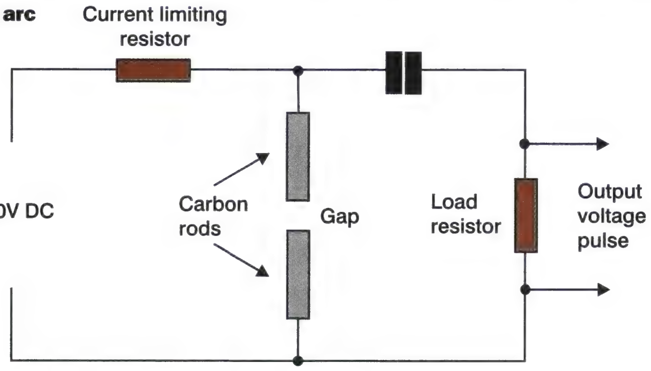


The complementary unit was identical to above

The DC generator constantly charges Cx. Ordinarily, gaps between main disc and side discs are too wide for a discharge to occur. So ioniser electrodes are located near to the gaps. When the rotating timer electrodes are located near to the gaps. When the rotating timer electrodes align with fixed electrodes, 'Cy' discharges through T1. The resultant very high voltage pulse energises the ionising electrodes thereby causing 'Cx' to discharge and create pulse through the coupling coil that shock excites the resonant antenna into oscillation. The main disc rotates at high speed, dispersing ions thereby quenching the discharge after each pulse and preventing energy from being transferred back to the exciter circuit.
Oscillations persist in the resonant antenna circuit and are re-enforced by each discharge. Oscillations in the antenna circuit are therefore continuous but not of constant amplitude. Pulse period is set by timer drive motor. Each discharge short-circuits the DC generator. Choking coils limit the current.

Figure 54. Simplified diagram of Marconi's 1916 300kW continuous wave timed spark transmitter.

Figure 55. The arc as a pulse generator.



With the arc extinguished, resistance across the gap is that of the dielectric strength of air. So the current goes to charging the capacitor. Normally, the arc would only ignite when potential of the charge in the capacitor exceeds the dielectric strength of the air within the electrode gap, typically in the order of several kV. So with potentials in the order of 500V the arc is initially ignited by momentarily bringing the carbon rods together.

Resistance through the arc falls and current is drawn from the capacitor much faster than the limiting resistor allows it to be replaced. So, the capacitor discharges and the potential across the arc falls. But because of its negative resistance characteristics, the resistance across the arc also falls. So the arc is sustained even though the capacitor is discharging and the potential across the arc falling. But ultimately the arc is no longer sustained - it returns to its high resistance state and the capacitor recharges.

Ordinarily, the arc would not re-ignite without the carbon rods being brought together again. But provided the gap is narrow and the pulse is not too slow, ions persisting in the gap facilitate re-ignition. So once started, operation becomes automatic. The time taken to recharge the capacitor sets the pulse repetition rate.

oscillations in phase and thereby produce continuous oscillations. The device was apparently used with early radiotelephone transmitters.

Continuous Waves - The Timed Spark

Unlike the synchronous spark that produced discrete wave trains, the timed spark transmitters generated precisely time wave trains that overlapped in phase and thus producing continuous oscillations. Little has been published on its operation but the following is how I believe it worked

The discharger was essentially the same as that used with the synchronised spark but the main disc did not have the copper rods around its periphery - it was a plain disc as shown in Figure 54. A 5kVDC, 300k generator delivering 50A charged the capacitor. Ordinarily the gaps between the main disc and the side discs would have been too wide to allow discharge, so ionising electrodes were located close by the gaps.

A discharge only occurred when the ionising electrodes were energised with ver high voltage pulses. Ionising pulses were timed to occur at the precise moment for trains of oscillations in the antenna circuit t overlap in phase.

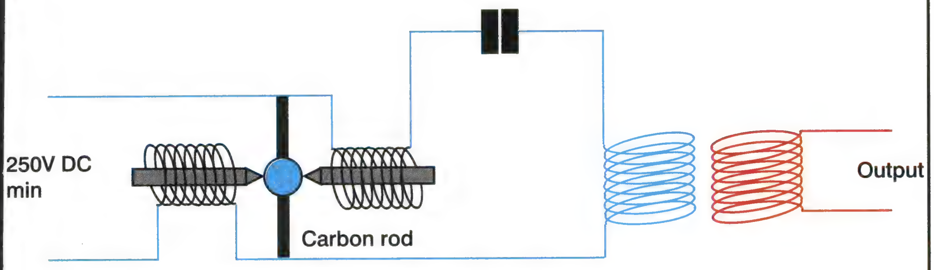
The discharge short-circuited the DC generator but here again choking coils limited the load on the generator and discharge current was drawn mainly from the capacitor. However, as the gaps were wide and ions were dispersed by the draft created by the disc rotating at high-speed, the arc was extinguished when the potential of the capacitor's charge fell to a lower level (see pulse generator - Figure 55). Oscillatory current in the primary circuit was therefore precluded.

Each discharge was a unidirection pulse that shock excited the resonant antenna into oscillation. Oscillations persisted in the antenna and progressively built up in amplitude by the reinforcements. So although the oscillations were continuous they were not of constant amplitude. See Oscillogram 'E'.

Timer

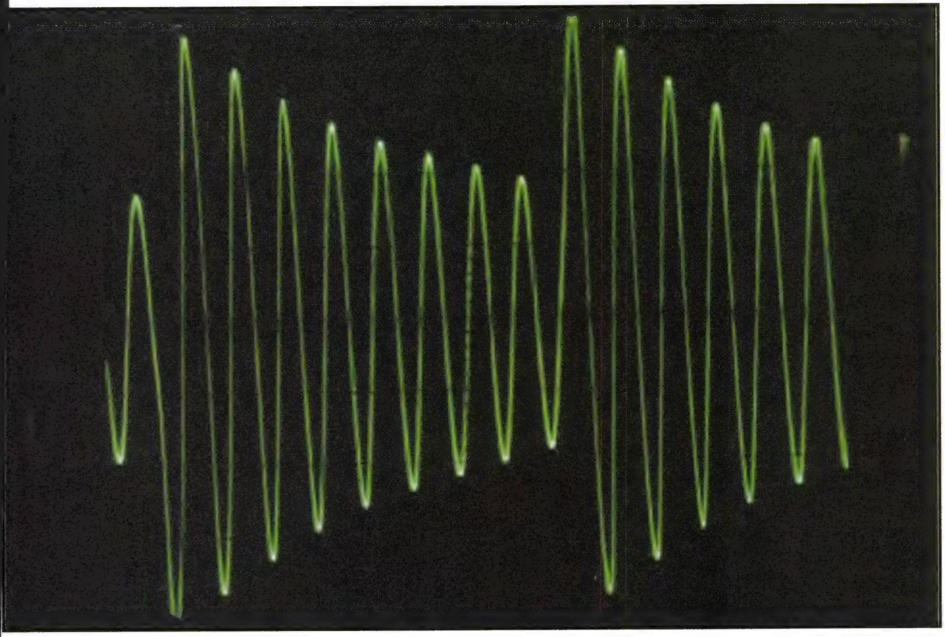
The timer had its own discharger that consisted of a disc with 16 projecting electrodes rotating between a pair of fixed electrodes - see Figure 54. When a pair of projecting electrodes aligned with a pair of fixed electrodes, the timing capacitor discharged across the gap thereby causing current pulse through the primary winding of a transformer. The result was a very high voltage pulse across the secondary winding that energised the ionising electrodes.

Current through the timing discharger was low so the electrodes had a gap width of only 1mm and a small face area. This close mechanical tolerance minimised timing errors that could be caused by changes in the dielectric strength of the air. But the drive motor actually set the timing so its speed had to be maintained within

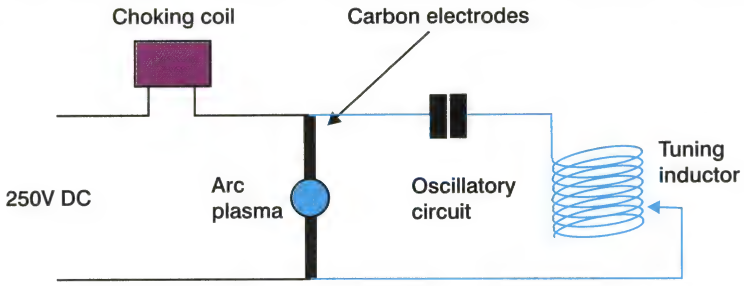


The electromagnets quench the arc when current through the arc reached maximum. Then the mmagnetic field collapsed and the arc was re-ignited thereby enabling pulses to be produced at a faster rate than with Figure 55. Because of the relatively low voltage of the supply current, initial ignition was by momentarily bringing the electrodes together. Once started, ions persisting in the gap make operation automatic.

Figure 56. Tesla's electromagnetic magnetic quenching system.



Oscillogram 'E'



The arc was in series with the resonant circuit, it was extinguished and re-ignited each half cycle. Capacitor charging now had to be synchronised with oscillations. With optimum values for the capacitor, inductor and 'arc gap' width, capacitor charging is automatically locked into synchronisation with the oscillations. Frequencies as high as 100kHz were reported, but I don not know how this frequency was measured. With a supply current of only 250V, re-ignition depended on residual ions.

Figure 57. Elihu Thomson's 1892 wave generator.

very close limits.

Overlapping seems to have occurred with every 11 cycles so in the meantime the amplitude of the oscillations declined as energy was radiated from the antenna. So to make amplitude as level as possible, two identical units worked in parallel but generated pulses timed so that the first half cycle of each successive wave train was 180° out of phase with that of the previous train. So overlapping would seem to have occurred with every 5½ cycles.

Whilst persistence of oscillations in the antenna system integrated wave trains into continuous oscillations and made the system workable it also limited the speed of signalling, which was by long and short transmission periods corresponding to the Morse code. Reception was typically by devices known as 'tikkers' that mechanically chopped radio frequency current into intermittent DC that produced an audible noise in the headphones.

Two timed spark transmitters, one of which was in reserve, were installed at Caernarvon in 1916. Both were rated at 200kW and efficiency was given as 60%, which was high by any standards. Wavelength was originally 11,000m but was increased to 14,000m. They were capable of 195 words per minute (wpm). In 1920 quenched arc transmitters replaced the timed spark transmitters.

Quenched Arc

The quenched arc transmitter evolved from an arc lamp. However, it is far from fully understood, and until I have conducted further experiments with my small-scale reproductions the best explanation I can offer is shown graphically in Figure 57. Perhaps some readers may come up with a clearer explanation.

Unlike the previous oscillators, the capacitor of the quenched arc transmitter was re-charged every cycle thereby maintaining oscillation at constant amplitude as energy was transferred to the antenna.

Negative Resistance

The quenched arc transmitter is based on the negative resistance characteristics of an electric arc. When the potential across the electrode gap is too low for an arc to strike it obviously presents an infinitely high resistance i.e. the dielectric strength of the air is the gap separating the electrodes. As the potential across the gap increases, a point is reached where the air dielectric breaks down and the arc strikes. Then resistance through the arc is then in inverse ratio to current flow.

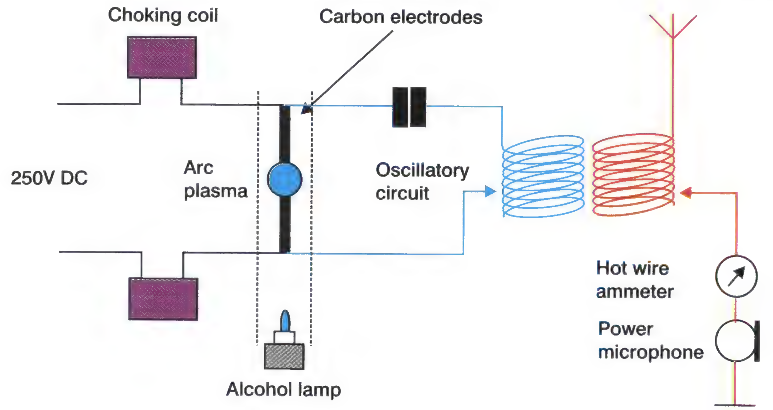
Pulse Generator

Let us first consider the electric arc as a basic pulse generator. A capacitor is connected across the arc electrodes and a variable resistor in the DC supply. See Figure 55

When the arc is extinguished the current passing through the limiting resistor goes to charging the capacitor. The arc strikes only when the potential of the capacitor's charge reaches the level greater than the dielectric strength of the air between the electrodes.

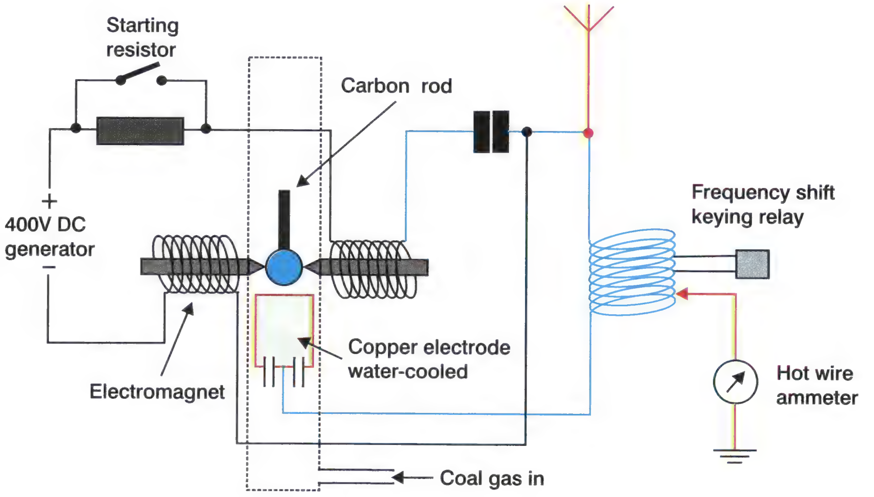
Once the arc strikes, resistance through the arc drops but because of the current limiting resistor, current for the arc is drawn from the capacitor faster than it can be replaced. The capacitor is ultimately discharged and the arc extinguished. Arc resistance returns to a high value and the capacitor recharges. The cycle is then repeated.

However, if the current limiting resistor passed sufficient current to sustain the arc, equilibrium would occur at some point in its resistance curve. Then the arc would burn



Remarkably, continuous wave transmitters were originally developed for radiotelephony. Note alcohol lamp in the arc chamber and power microphone were designed to carry a heavy current. The lamp provided additional ions and facilitated re-igtnition of the arc every half cycle.

Figure 58. DeForest's continuous wave transmitter for radio telephony.



Based on contemporaneous drawings. ▬ capacitor charger and electromagnet circuit and ▬ arc or oscillatory circuit.

This combined Elihu Thomson's wave generator, Tesla's electromagnets, Lepel's water cooled electrode and the principle of Deforest's alcohol lamp.

The arc was initially ignited by momentarily bringing the electrodes together. The resistor is in the current supply to prevent overload of the DC generator. Thereafter re-ignition was automatic and the resistor was shunted. Note frequency shift keying was achieved by shorting out a few turns of the tuning inductor.

Figure 59. Pouslen quenched arc 100kW transmitter.

continuously albeit at low intensity with the capacitor partly charged. So, to ensure that the arc is extinguished, the value of the limiting resistor must be so high that direct current flow is unable to sustain the arc. However, as the capacitor is slow to charge the pulse repetition rate is slow.

To ensure the arc was quenched, Tesla inserted electromagnets in the arc circuit. When current through the arc reached maximum, the magnetic field 'blew' ions away from the gap thus periodically quenching the arc and producing pulses. Residual ions facilitated re-ignition of the arc by the reverse current - see Figure 56.

Oscillator

When an inductor is connected in series with the capacitor it becomes a resonant circuit and with careful selection of component values it can be made to behave as an oscillator. The arc is therefore ignited and quenched as the current reverses with each half cycle. So, capacitor charging must be synchronised with the oscillations. The choking coils isolate the oscillatory current from the DC source.

Operating frequency is set primarily by the value of the inductor and capacitor but with the arc itself and the current limiting resistor playing a significant role. Let us no look briefly at some of the pioneers whose work led to the development of high powe quenched arc CW transmitters

Elihu Thomson

In 1892, Elihu Thomson patented an arc type CW oscillator with a frequency probably in the order of 100kHz. It became known a Elihu Thomson's 'wave generator' - see Figure 57

DeForest

Around 1906, DeForest developed Elihu Thomson's wave generator into a radio telephony transmitter. Indeed, it was radiotelephony that originally motivated development of continuous wave generators Modulation was by means of a 'power' microphone inserted in the antenna system

It ran on a fairly low voltage and needed to be started by momentary bring the carbon electrodes together. Thereafter, re-ignition was automatic and facilitated by ions released from an alcohol lamp burning in the arc chamber. See Figure 58

Von Lepel

Von Lepel employed water-cooled electrodes and remarkably, integrated a tone generator into the system that modulated the transmission; this enabled the telegraphy transmission to be received with rectifier type detectors. A 100 kW Lepel transmitter was installed at the Eiffel Tower radio station around 1910.

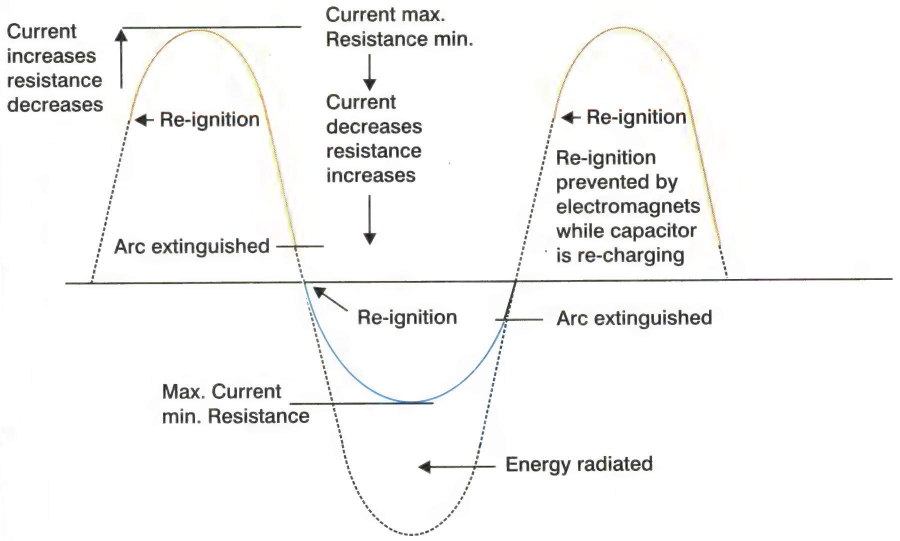
Poulsen

With his high power transoceanic telegraph transmitter, V. Poulsen combined Tesla's electromagnets with Von Lepel's water-cooled electrodes. However, his transmitter operated on a voltage of only 500V and it incorporated DeForest's method of providing ions to facilitate re-ignition but employed a stream of hydrogen rich coal gas. See Figures 59 & 60.

As with conventional arc lamps, Poulsen's transmitter incorporated a mechanism to automatically advance the carbon electrode as it burned away and thereby maintain the correct gap with the copper electrode. But to ensure that the end of the carbon electrode remained flat, it rotated against a scraper. The carbon electrodes needed frequent replacement but the water-cooled copper electrode lasted for a few months.

Stop and start keying, where the transmission consists of short and long periods to represent the Morse code, could not be applied to Poulsen's transmitter. Once started, by momentarily bring the electrodes together, it had to continue running; this was no problem with low power early versions designed for radiotelephony

For transoceanic operation, frequency shift keying was adopted and attained by shorting out a few turns of the tuning inductor. See Figure 59. As the transmission


Current increases resistance decreases
Current max.
Resistance min.
Current decreases resistance increases
Re-ignition
Re-ignition
Re-ignition prevented by electromagnets while capacitor is re-charging
Arc extinguished
Re-ignition
Arc extinguished
Max. Current min. Resistance
Energy radiated

The author's interpretation from his own experiments with a small scale reproduction.

Gaps in the waveform are 'filled' by the flywheel effect of the resonant circuit, typically the antenna. The arc is extinguished near the end of the positive-going half cycle when the capacitor has discharged to a low potential. It is re-ignited by the reverse current at the start of the negative-going half cycle.
Radiated energy reduces the magnitude of negative-going half cycle. So, the potential of the following positive-going half cycle may be insufficient to re-ignite the arc.
During oscillation, the electromagnets serve as choking coils to isolate the oscillatory circuit. When the arc is extinguished, DC passes through the electromagnets and re-charges the capacitor. Their magnetic field prevents re-ignition during the charging period. When the capacitor is charged to its full potential, current through the electro-magnets ceases. Their magnetic field collapses and ions provided by the gas facilitates re-ignition - and so the process is repeated.

Figure 60. Poulsen quenched arc - current through the arc.

was not modulated, Tikker type receivers were employed, and as already mentioned, directly convert radio frequency current into intermittent DC that produced an audible noise in headphones.

Contemporaneous diagrams show direct antenna connection; this does seem to question my explanation of its operation that would require energy to be transferred to the resonant antenna via inductive coupling. But contemporaneous diagrams are not always correct. Efficiency for 100kW machines was given as 35/40% as much energy went into and heating of the electrodes and the magnetic field.

Probably the best known Poulsen transmitters were those at the superstations that worked commercially between San Francisco and Honolulu, a distance of 3,600km - see Photo 'D'. Both were rated at 100kW. Wavelength was probably in the order of 7,000m. During WW1, a 60kW Poulsen transmitter was installed at the Eiffel Tower where it transmitted military messages.

A high power Poulsen transmitter was installed at Marconi's Caernarvon station directly after WW1 as a reserve for the timed spark transmitter. Unfortunately, it was incapable of delivering more than 170A to the antenna, compared with more than 200A with timed spark. Furthermore, it could not be worked for long periods without giving trouble.

Marconi's Clifden Transmitter

The Clifden transmitter was commissioned in 1906 and its sister station at Glace Bay were physically the largest transmitters ever built and both were derived from knowledge gained empirically. It must have required enormous confidence to construct such stations knowing that nothing like them had been built before. Wavelength of the Clifden station was 6,666m - see Figure 61.

Marconi described the transmitter as being a cross between a spark and an arc system. Unfortunately, I found the circuit diagram to be confusing. But, based on the fact that it produced continuous oscillations, the frequency was set entirely by its resonant circuit and since it operated on DC, I am convinced that it was a quenched arc system. So operation would have been electrically similar to Poulsen's system.

The Clifden and Glace Bay transmitters were more or less identical. Let us consider the Clifden transmitter. Remarkably, the dischargers were basically the same as those used with the later synchronised spark and timed spark transmitters.

Although the Clifden transmitter predated Poulsen's transmitter by a few years, it was far more elegant and reliable than Poulsen's device. The main disc revolved at high speed thereby dispersing ions whereas Poulsen employed electromagnets. Moreover, it was self-cooling thus avoiding the need for a water-cooled electrode. Its disadvantage was its high operating voltage, 12kV compared to 400V with Poulsen's system. Nonetheless, the high voltage facilitated arc re-ignition without the need to provide additional ions.

The capacitor had air dielectric and was therefore self-healing. It consisted of zinc plates 8m tall and 3.5m wide suspended 300mm apart from insulated beams. A large building was therefore necessary just to house this giant capacitor - see Photo 'E.' The enormous antenna tuning coil and coupling coil is shown in Photo 'F'

Power was provided by a steam engine burning peat mined nearby and transported

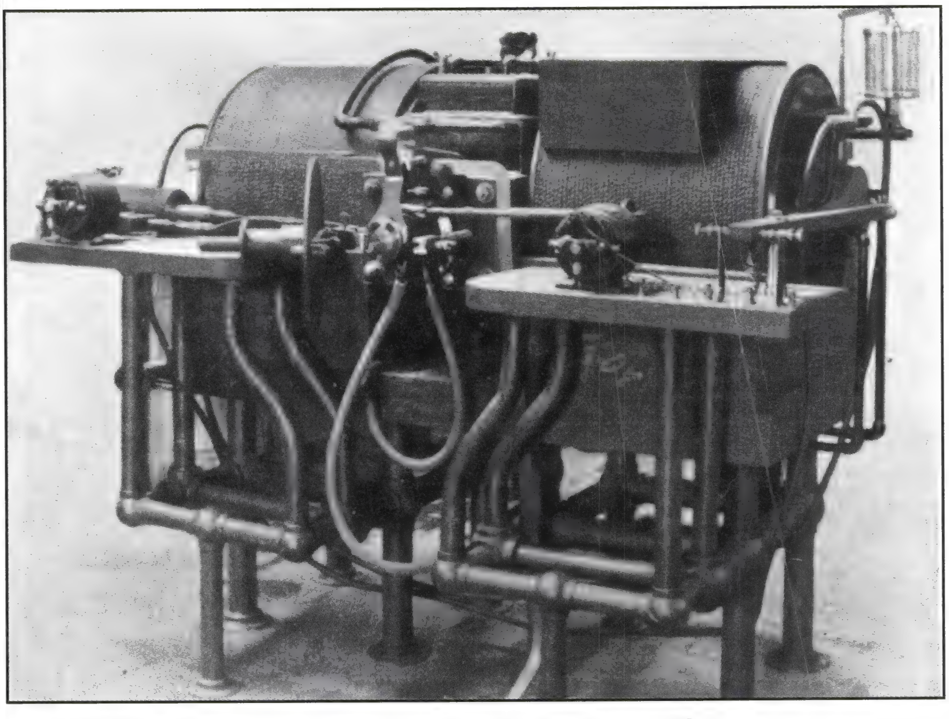
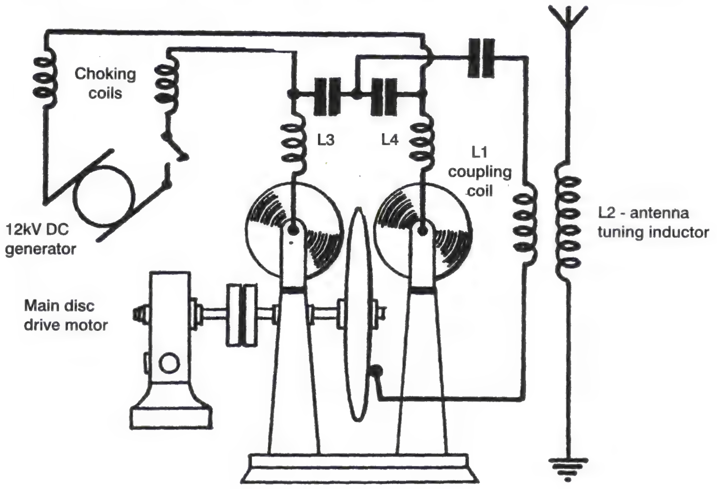


Photo 'D'. 100kW Poulsen arc generator at the San Francisco station.



Role of L3 & L4 is unknown

Note high-spped, triple-disc discharger, and compare with Poulsen's transmitter of figure 56. See size of the antenna coupling coil and antenna tuning inductor in Photo 'D'.

Figure 61. Contemporaneous simplified diagram of Marconi's 1907 Clifden transmitters.

directly to the boiler house by a light railway. The generator provided an output of 300kW at 20kVDC and charged 6,000 40Ah secondary cells giving a working voltage of 12kV. Another large building was required to house the batteries. Unfortunately my circuit diagram does not show how keying was accomplished.

Shortly after the station was commissioned, the carborundum rectifier type detector was developed. But as unmodulated CW could not be resolved with rectifier detectors it was decided to modulate the transmission with tone by inserting small studs around the periphery of the main disc.

The Clifden station worked Glace Bay, Newfoundland from 1906 until destroyed during Irish independence troubles during WW1; it was not rebuilt. Thereafter the Caernarvon station handled transatlantic communication. So with these notes on this remarkable transmitter I conclude this part of the study.

Next Month..

In part 5 we look at alternator systems pioneered by Tesla and ultimately dominated pre-valve very long wave transmitters. Indeed they are still used with submarine signalling systems

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Davis JR: A Quest for a Controllable ULV Wave Source
Fessenden CT: Development of a trailing-wire E-Field ELF Submarine Reception Antenna
Harrison ER: Extremely Low Frequency Communication with Submarines
Keiser BE: Early Development of Project Sanguine Radiating System
Wait JR: Propagation of ELF Electromagnetic Waves and Project Sanguine/Seafarer

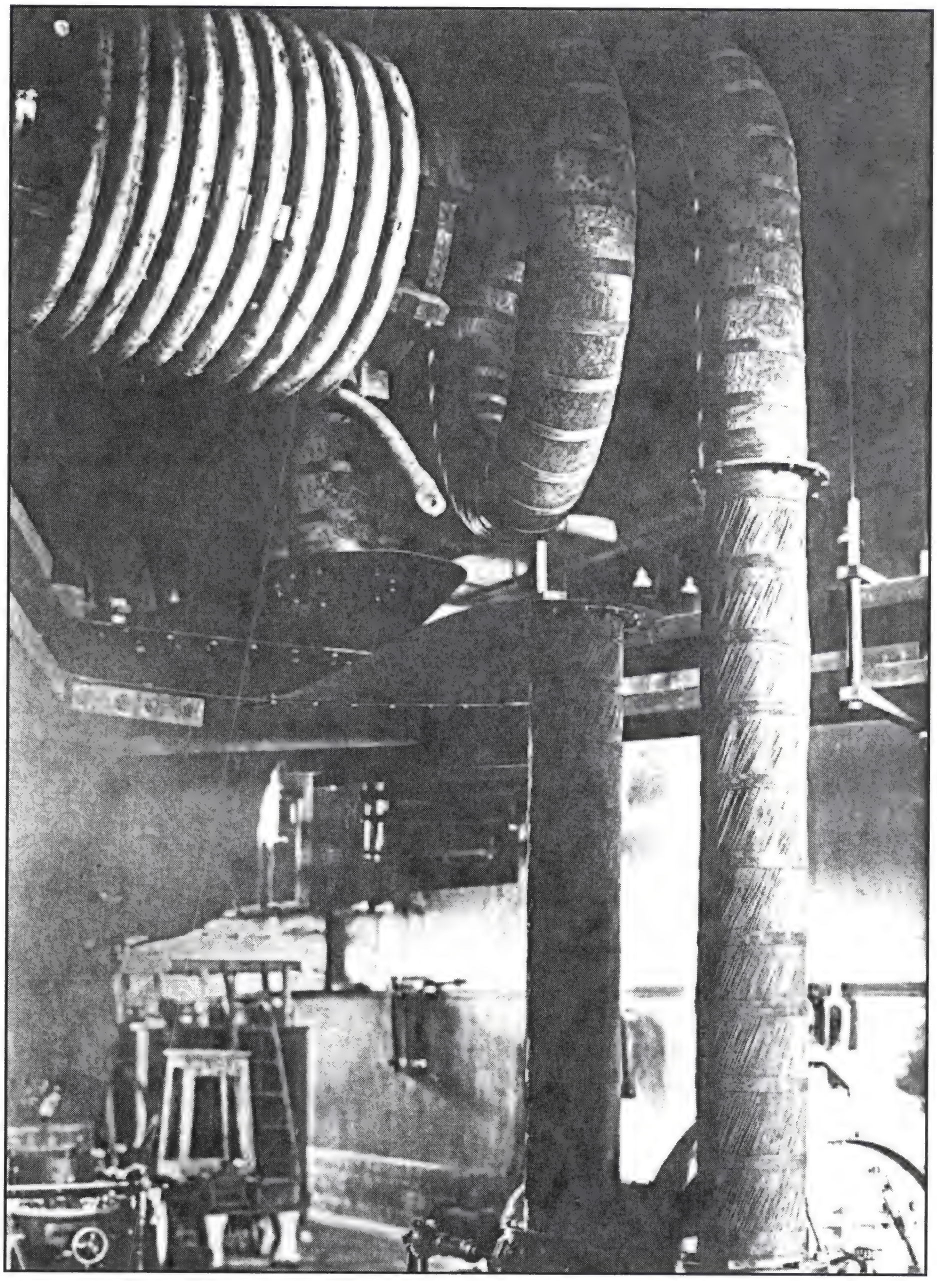


Photo 'F'. The antenna transformer Clifden c1908.

@Internet Special

8-page pull-out

Fast, Faster, Fastest

For most readers Internet access is with a modem. However, while they have increased in speed over the past few years, modems have finally reached their effective limit. In effect, modems are as good as they can get - at 56Kbps, the telephone lines on which they rely can no longer support any further increase. So, on a fine day, with the wind behind us, we may be able to reach a usable speed with our modems of around 48Kbps and, if we're very lucky the connection might not reduce too much during the time of the call and, indeed, might even stay online at all.

Other technologies exist. Most famous is ISDN, with its digital connection and reliable speeds of 64Kbps or 128Kbps if we join the standard two channels into one.

But the most exciting new technologies are just about to burst onto the scene. Like ISDN these are based on digital technologies so offer much more reliable connections than modems, and they are both significantly faster than even ISDN.

Digital subscriber line (DSL) is the technology favoured by BT. BT's preferred method of DSL is known as asymmetrical digital subscriber line (ADSL). BT is - rather confusingly - calling its ADSL service BT Highway (which is remarkably close in name to BT existing ISDN services: BT Home Highway, and BT Business Highway). Once you've got your mind around its name, though, you'll be happy to hear that BT Highway will be an always-on service - that is, when you turn on your computer, the ADSL link becomes active. It's also a flat-rate cost - at a proposed £40 a month or so.

The cable telephone and television companies have their own system, called cable modems, but these aren't modems at all. They're digital connection boxes, just like ADSL equipment. Like ADSL, cable modems provide an always-on, flat-rate (at around £40 a month, too) service, with equivalent digital reliability.

Both systems allow download speeds of 500Kbps. With time, faster systems will be created at increased cost, for larger businesses and corporate users. Mind you, the download speed does depend on the fact that connections are contended with other users and are not dedicated (as they are on ISDN). BT Highway will have a contention ratio of 50:1 for its entry level system, so theoretically your actual download speed could be as low as 10Kbps, but that's a worst-case scenario, and BT expects that typical real speed will not be anywhere near that low. In a realistic scenario, download speeds will actually be defined more by your ISP's connection to the Internet backbone: not your digital connection to your ISP - a chain's only as strong as its weakest link, after all.

So, when can we have fast Internet connection? The short answer is - eventually. ADSL is scheduled for general release in the Autumn, while cable modems are being rolled out slowly around the country already. So apart from a few lucky people who are trialling either service, the rest of us will just have to wait!

Secure e-commerce For Users

PIPEX has joined forces with IBM to produce an easily usable solution for small to medium sized business who want to set up an online sales site. PIPEX Websell is priced from £15 a month, but is free to all existing PIPEX Dial users, which means that PIPEX is the first ISP to offer e-commerce facilities to its users as part of its standard Internet services.

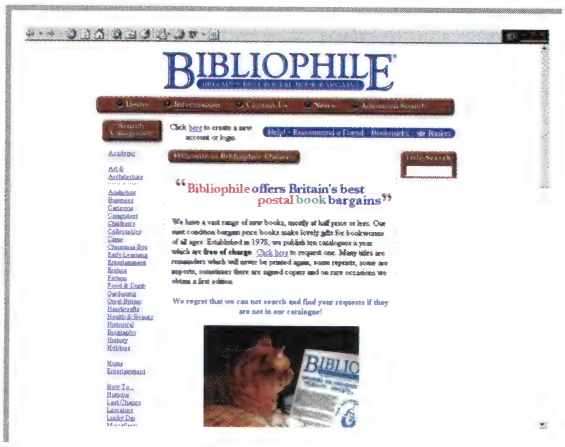
PIPEX users set up their Website using the tools within Websell, such as an online catalogue builder that produces your site complete with images and descriptions of products and shopping carts. A secure payment facility is provided by a leading payment service provider (PSP) NetBanx. Payments can either be routed direct to a user's merchant bank (if the user already has credit/debit card facilities), or can be through NetBanx's own merchant scheme. Either way, NetBanx charges a processing fee for each transaction. Deliveries to customers is through ParcelForce Worldwide, and customers are able to track parcel delivery online through the user's Website.

Oftel Puts the Screw on BT

BT is being forced to let rival Internet service providers have access to its network for a low annual tariff on a wholesale, unmetered basis, in a move that looks set to bring forward the day when all Internet access over telephone lines is free. Oftel, the telecoms watchdog, reacted to a complaint by MCI Worldcom that although BT was launching its Surftime Internet access, BT was not allowing other licensed operators access to its network at competitive rates. Oftel found that this was true and, as this is obviously uncompetitive, has the power to force BT to offer the facility to all operators. This it has done, and the new pricing structure takes effect from the date (June 1) when BT Surftime was launched.

It's interesting that Oftel's general rulings on unbundling of local loops from BT to other operators has been literally years in the making (and will be a while yet coming to fruition), but an official complaint by one of BT's competitors on a single point of BT practise means that decisions can be reached almost immediately.

Bibliophile Launches Cut Price Book Site



Click here to create a new account or login

"Bibliophile offers Britain's best postal book bargains"

We have a vast range of new books, mostly at half price or less. Our mint condition bargain price books make lovely gifts for bookworms of all ages. Established in 1978, we publish ten catalogues a year which are free of charge. Click here to request one. Many titles are remainders which will never be printed again, some reprints, some are imports, sometimes there are signed copies and on rare occasions we obtain a first edition.

We regret that we can not search and find your requests if they are not in our catalogue!

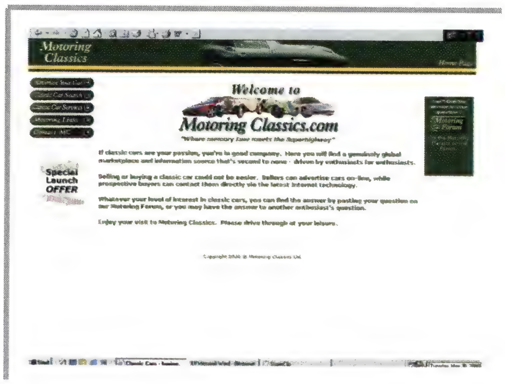
Bibliophile Books, long time home to many of the UK's best book bargains is now online at **`<www.bibliophilebooks.com>`**.

Over 4,000 titles with over 200 new titles a month are available on the site mostly at discounts of 50% off the published price and each title is accompanied by a full review written by the Bibliophile editorial team.

The Bibliophile Review Library of 13,500 titles is available for electronic use under license.

Founded in 1978, Bibliophile has been successfully selling the UK's finest selection of titles painstakingly culled from publishers' back lists.

Motoring Site is a Classic



Welcome to Motoring Classics.com

If classic cars are your passion, you're in good company. Here you will find a genuinely global marketplace and information source that's second to none - driven by enthusiasts for enthusiasts.

Selling or buying a classic car could not be easier. Sellers can advertise cars on-line, while prospective buyers can contact them directly via the latest Internet technology.

Whatever your level of interest in classic cars, you can find the answer by posting your question on our Motoring Forum, or you may have the answer to another enthusiast's question.

Enjoy your visit to Motoring Classics. Please drive through at your leisure.

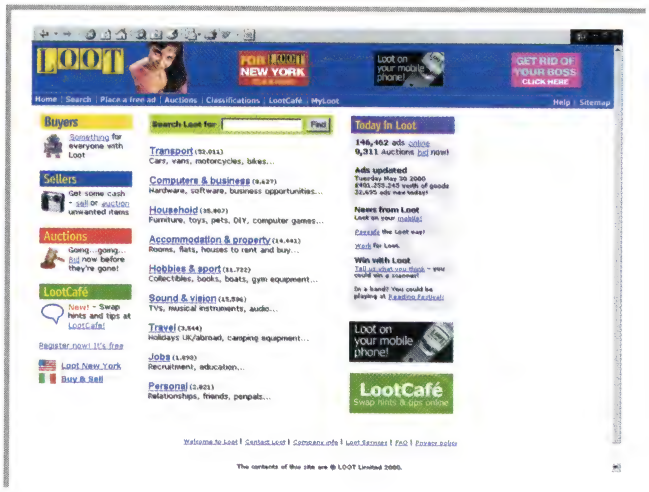
Motoringclassics.com at **`<www.motoringclassics.com>`** is a Web site dedicated to classic car enthusiasts, giving drivers, owners, buyers and sellers of classic and prestige cars a new home on the Internet.

Whether you're selling a Bentley or buying a Bugatti, need storage for a Saab or want insurance on a Jenson Interceptor, motoringclassics.com is the number one place on the Internet for lovers of automobiles that stand out from the crowd.

The site, which is offering three months of free advertising to the first 500 subscribers, also boasts individual discussion forums for every classic car marque, where people can swap experiences and hints and tips with fellow marque owners.

An extensive list of classic car service providers around the UK is also available, as are links to owners clubs from around the British Isles.

Sight and Sound at Loot.com


LOOT
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Help | Sitemap
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Get some cash - sell or auction unwanted items

Going...going... Bid now before they're gone!

New! - Swap hints and tips at LootCafe!

Register now! It's free

Loot New York

Buy & Sell

Transport (32,011)
Cars, vans, motorcycles, bikes...

Computers & business (8,427)
Hardware, software, business opportunities...

Household (35,807)
Furniture, toys, pets, DIY, computer games...

Accommodation & property (14,441)
Rooms, flats, houses to rent and buy...

Hobbies & sport (11,722)
Collectibles, books, boats, gym equipment...

Sound & vision (15,596)
TVs, musical instruments, audio...

Travel (3,844)
Holidays UK/abroad, camping equipment...

Jobs (1,893)
Recruitment, education...

Personal (2,821)
Relationships, friends, penpals...

146,462 ads online
9,311 Auctions bid now!

Ads updated
Tuesday May 30 2000

News from Loot
Loot on your mobile!

Win with Loot

In a band? You could be playing at Reading Festival!

Welcome to Loot | Contact Loot | Company info | Loot Services | FAQ | Privacy policy

The contents of this site are © LOOT Limited 2000.

Loot.com at **`<www.loot.com>`** - the UK's largest consumer buying and selling Web site with over 13.8 million page impressions a month - provides the perfect online tool for consumers wishing to set up their ideal home entertainment system.

Loot.com hosts an extensive sound and vision section which is home to thousands of ads for TVs, VCRs, DVD players and hi fi equipment. On site, you can find items to your requirements, whether you're looking for a colour Sony portable for the kitchen or a Bang and Olufsen TV for the lounge at much lower than the recommended retail price.

The site utilises a powerful search engine that allows users to search through the ads in seconds. By entering simple search criteria such as brand name and geographic location, Loot.com quickly displays all relevant ads on screen in seconds with telephone or e-mail contact details.

Selection of ads from the Loot.com sound and vision section:

1. Sony 29in, brand new, in box, Nicam stereo, remote control, Argos price £450. Loot.com price £285;
2. Panasonic L50DVD player, portable LCD screen, region 2, Dolby digital, remote, rechargeable battery pack, optical & SVHS out speakers, mint condition. Loot.com price £450;
3. Toshiba DVD player, brand new, never been used, recommended retail price £300. Loot.com price £150; and,
4. Sony SLV/SE 80 smart engine, Nicam stereo, brand new, recommended retail price £330. Loot.com price £175.

BeSonic.Com Bursts onto UK Music Scene

BeSonic.com at **<www.besonic.com>**, the unsigned band community Web site and fastest growing source of legal free music over the Internet, is opening an office in London.

BeSonic.com has been expanding quickly since its launch in September 1999 and has a truly international audience.

With over 13,000 free tunes - ranging from ambient house to classical - available to download on the site, music lovers can find original, CD-quality music that they cannot experience through traditional sources.

zoom.co.uk to Launch WAP Shopping Service

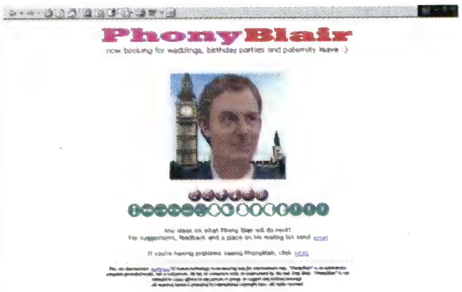
Zoom.co.uk, one of the UK's most successful shopping sites with 60% of its users making regular transactions, has launched wap.zoom at **<wap.zoom.co.uk>**.

Over a secure transactional platform, WAP users on Zoom will for the first time be able to shop, e-mail and receive news live from Zoom.co.uk.

Using WAPorizer technology, owners of WAP enabled phones will be able to read, reply and compose e-mails from their Zoom Web-based e-mail, access the latest fashion news, get up to the minute weather reports and horoscopes.

And, from early June, Zoom WAP surfers will be able to buy the latest fashion while on the move straight from their WAP phone.

phonyblair.com Shows Potential of Modeling Technique



While Tony Blair and wife Cherie recuperate from the birth of their new son, a team of UK software developers have created a 3D virtual Tony Blair stand-in, at **<www.phonyblair.com>**. PhonyBlair is the latest 3D virtual human to hit computer screens.

An interactive, photo-realistic animated caricature of Prime Minister Tony Blair, PhonyBlair showcases the latest developments in the creation of 3D 'Virtual Humans' or 'avatars'.

PhonyBlair's head can be rotated through 360 degrees and his features and facial expressions exaggerated, while he can even be made to sport a mohican-style haircut and to moo like a cow.

Developed by BioVirtual, a team of UK software developers, PhonyBlair represents a significant leap forward in the creation of a 3D 'Virtual Humans' or 'avatars'.

A number of companies have shown virtual humans on the Internet already, but have actually demonstrated semi-realistic cartoon style characters, produced with the latest computer graphics software at significant expense.

As impressive as some of these are, they do not represent true photo-realism, which is what the BioVirtual team have achieved.

The technology behind PhonyBlair has a diverse range of applications. In the first instance, it will help police produce accurate 3D composite images of criminals.

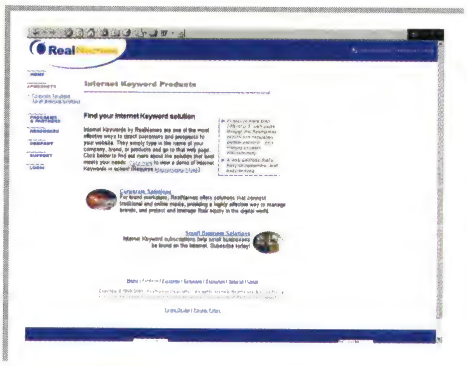
Using technology developed over a three-year period in conjunction with experts at New Scotland Yard, BioVirtual's engineers have perfected a method of applying the actual bitmap image from one or more photographs to an anatomically accurate 3D model, to produce truly photo-realistic 3D virtual humans.

BioVirtual has teamed with Aspley to supply the first commercially available 3D E-FIT product for police and security applications.

How to load the BioVirtual 3D model:

1. Load URL **<www.phonyblair.com>** in your browser;
2. Click on the Pulse logo - this will load the Pulse Entertainment site in a new instance of the browser;
3. Maximise this new window so the Pulse cube can be seen;
4. Click on 'Click here to install' (not 'Click here to continue') - message will indicate 'Verifying Pulse Player installation...';
5. Wait approximately 90 seconds on a 56k modem link - modem light are the only indication of activity, unfortunately;
6. Click 'Yes' when the 'Security warning' Window pops-up to advise of plug-in installation;
7. Click 'Agree' when 'License Agreement' Window pops-up to advise of free license terms;
8. When 3D spinning cube can be seen, close this browser window and return to **<www.phonyblair.com>**; and,
9. Click the link labelled 'click HERE...' and after approximately 15 seconds, PhonyBlair will appear.

UK Government Registers Real Names



The Prime Minister's Office has registered a number of Internet key words with Real Names at **<www.realnames.com>** to make it easy for users to go direct to its Web site.

Internet Keywords allow people to use brand names, familiar words or phrases to easily find the information they are looking for on the Web.

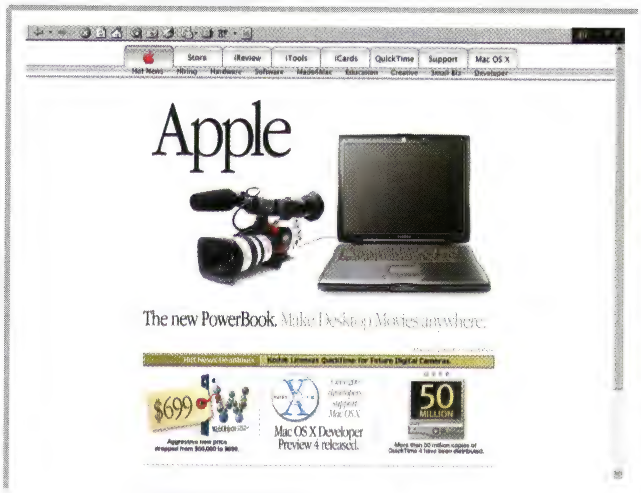
These latest Internet Keywords allow users to go straight to the Prime Minister's Web site simply by typing a number of commonly used and recognisable names into Microsoft's Internet Explorer browser and many popular search environments.

The names registered by the Government include amongst them: Number 10, Tony Blair, Downing Street and UK Government.

The Web site of the Prime Minister's Office provides a comprehensive daily news service covering all the Government's events and announcements.

It is also a gateway to the rest of the Government with all the latest information including manifesto commitments and video footage of the Prime Minister's questions from the House of Commons.

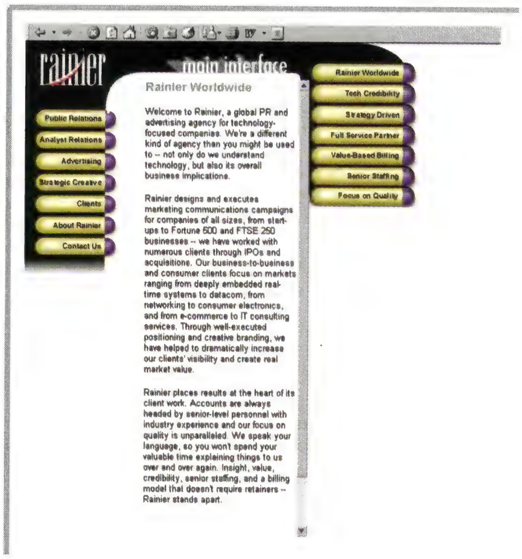
Apple.com Named Number One Movie Trailer Site


Store
iReview
iTools
iCards
QuickTime
Support
Mac OS X
Hot News
Hiring
Hardware
Software
Made4Mac
Education
Creative
Small Biz
Developer
Apple
The new PowerBook. Make Desktop Movies anywhere.
Hot News Headlines
Kodak Licenses QuickTime for Future Digital Cameras.
$699
WebObjects
Aggressive new price dropped from $50,000 to $699.
Mac OS X Developer Preview 4 released.
50 MILLION
More than 50 million copies of QuickTime 4 have been distributed.

Apple has distributed more than 50 million copies of its QuickTime 4 player software and in particular has been distributed to Mac and Windows users worldwide.

In addition, Nielsen//NetRatings has named Apple's Web site, **<www.apple.com>**, the most popular destination for movie trailers on the Web.

10 Things To Do When E-mail Goes Down



Rainier Worldwide

Welcome to Rainier, a global PR and advertising agency for technology-focused companies. We're a different kind of agency than you might be used to -- not only do we understand technology, but also its overall business implications.

Rainier designs and executes marketing communications campaigns for companies of all sizes, from start-ups to Fortune 500 and FTSE 250 businesses -- we have worked with numerous clients through IPOs and acquisitions. Our business-to-business and consumer clients focus on markets ranging from deeply embedded real-time systems to datacom, from networking to consumer electronics, and from e-commerce to IT consulting services. Through well-executed positioning and creative branding, we have helped to dramatically increase our clients' visibility and create real market value.

Rainier places results at the heart of its client work. Accounts are always headed by senior-level personnel with industry experience and our focus on quality is unparalleled. We speak your language, so you won't spend your valuable time explaining things to us over and over again. Insight, value, credibility, senior staffing, and a billing model that doesn't require retainers -- Rainier stands apart.

Following the worldwide problems caused by the Love Bug computer virus, marketing agency Rainier at **<www.rainierco.com>** has produced a 10-point list to help office workers get on with their jobs without e-mail.

Top 10 things to do without e-mail:

1. Talk in loud tones of your wonder at what people did before e-mail. Wonder at productivity increase;
2. Find a book on the use of English grammar and amaze yourself at your complete ignorance of how to use it;
3. Go to the pub early and discuss the merits of continued employment for those who sent or opened a freak e-mail entitled 'I Love You'. Drink to the hackers who caused you to be there;
4. Blow the dust off your phone book and ring your parents, remind them who you are and explain what e-mail is;
5. Find the life you left behind when first you logged on. Log off at the last page of the Internet at **<www.wackycreations.com/lastpage.html>**;
6. Pull out the Yellow Pages. Ring up market research companies and offer to take part in any surveys they're currently running;
7. **<www.eeggs.com>** to find out how to access hidden games and utilities in common computer operating systems and applications;
8. Re-programme databases, desktop and mobile phones and faxes to account for the recent UK phone number changes;
9. Set-up a chair racing circuit round your office and line-up the swivel chairs for a spot of office Grand Prix; and,
10. Spot the companies trying to cash-in on the Love Bug virus and admire their creative ingenuity.

Unacceptable Download Speeds Leave UK Waiting for E-Commerce

The UK is in danger of losing out on e-commerce revenues due to unacceptable download times according to the results of a study published in May by Internet caching appliance providers, CacheFlow at **<www.cacheflow.com>**.

The study provides the clearest indicator yet of the likely winners and losers in the race to create successful e-commerce businesses, with UK sites polarised between acceptable and appalling download speeds.

The CacheFlow study found Web users in the UK typically have to wait an average of 28 seconds for a Web page to download from an e-commerce site, but that waits of two or three times this figure are not untypical.

A report issued by US Internet analyst Zona Rearch in June 1999 stated that Internet shoppers are likely to leave an e-commerce site if they are unable to download Web pages in less than 8 seconds.

Travel

In the travel category, the study found that Web pages from EasyJet, the cut price airline, took an average of 10.7 seconds to download, whilst its traditional counterpart British Airways had an average download time of 33.7 seconds - three times slower.

Books

In the book category bol.com, the Internet bookstore took an average of 17.7 seconds to download, compared to high street bookstore Blackwells with an average download time almost three times slower at 47.6 seconds.

Financial Services

But in the financial services sector, Web pages at Internet bank Egg took an average of 47.6 seconds to download compared with LloydsTSB at 17.3 seconds.

Search Engines

In the search engine category, Lycos and Excite had averages of 8.3 seconds and 8.4 seconds respectively, almost five times faster than AltaVista and Yahoo which had average download times of 31.7 and 47.7 seconds respectively.

Supermarkets

In the supermarket category Tesco, which has invested heavily in the Internet as an ordering channel for customers had an average download time of 16.4 seconds per Web page, almost half that of rival Somerfields.

The study investigated the download times of 50 leading UK e-commerce Web sites across 13 business categories over a period of two weeks. The test was conducted using 56k dial-up accounts from half a dozen different Internet Service Providers. Each site was hit 10 times over the two-week period, at a variety of times throughout the day.

The most surprising finding of the survey was the lack of consistency in terms of performance between companies in the same category, and old-style retailers versus younger upstarts that are building businesses solely on the Web.

Eight of the top ten fastest Web sites are businesses that have been developed specifically on the Web such as lycos.co.uk, excite.co.uk, thetrainline.com and bol.com.

By comparison six of the top ten slowest sites are traditional businesses that have developed an e-commerce Web presence to compliment existing channels. The notable exception here is Boo.com, the online clothes stores that has suffered mixed fortunes over the last 12 months.

Forrester Research's Retail Pan-European Future published in March 2000, foresees a dramatic re-shaping of the European retail landscape as e-commerce sales grow 98% annually over the next 5 years. Starting from £1.73 billion in 1999 sales will reach £104 billion in 2005. CacheFlow believes that slow download times may well hinder this progress in the UK.

Terra to Acquire Lycos

Terra Networks at **<www.terranetworks.com>** is set to acquire Lycos at **<www.lycos.com>** in a bid to create the first truly global Internet company.

The combined company will be built on a unique platform that capitalises on the convergence of Internet services, new media, branded content, e-commerce, and next-generation communication technologies.

Terra and Lycos expect pro forma 2000 revenues of approximately £300 million and together currently have an estimated 50 million unique users and 175 million page views per day.

Terra Lycos will have operations in 37 countries, with leading positions in multiple high-growth markets in North America, Latin America, Asia and Europe.

Top 100 Bookmarked Sites Released by Hotlinks

HotLinks at **`www.hotlinks.com`** has released the top 100 list of the most popular sites bookmarked by HotLinks members for the month of May.

The HotLinks 100 data offers a glimpse into what Web sites Internet users like, save and utilise to navigate the Web.

Unlike several other Internet user measurement tools, which take a look at page views of Web users, the HotLinks 100 identifies the sites that people take the time to bookmark and use over and over again, the sites that people really find valuable.

Top Ten HotLinks' sites:

1. www.microsoft.com
2. www.looksmart.com
3. www.real.com
4. www.city.net
5. www.yahoo.com
6. www.miningco.com
7. www.abc.com
8. www.fedex.com
9. www.geocities.com
10. www.simplenet.com

Store Passwords Safely on the Web

Unlockme.com at **`www.unlockme.com`**, a new online password retrieval site, announces the launch of a Web site that eliminates the frustration of remembering a different user ID and password for every site visited on the Web, without yielding hard drive access.

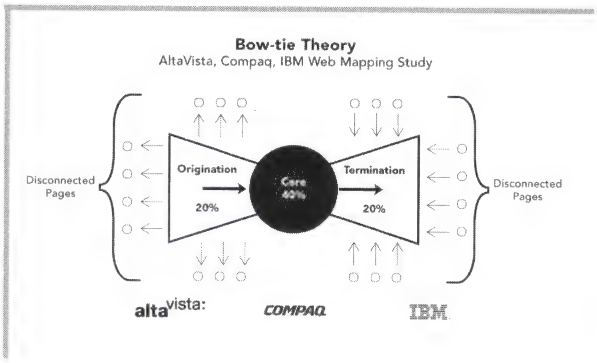
Unlockme.com offers a free virtual service that allows Internet users to safely store and retrieve IDs and passwords while browsing the Web.

Unlike other ID and password storage programs, Unlockme.com ensures complete privacy and unlimited access by eliminating the need for hard drive connection.

Sensitive data is fully encrypted and all ID and password information is protected through industry-leading SSL (Secure Socket Layer) technology to ensure user information security. In short, this site offers a 100% virtual solution to an age-old problem.

A first of its kind, Unlockme.com is completely free and private with nothing to download or install.

Researchers Create Accurate Picture of the Web



Scientists from IBM Research, Compaq and AltaVista have completed the first comprehensive map of the Web, and uncovered divisive boundaries between regions of the Internet that can make navigation difficult or, in some cases, impossible.

Previous studies, based on small samplings of the Web, suggested that there was a high degree of connectivity between sites as evidenced by recent reports on the small world Web and 19 degrees of separation.

Contrary to those preliminary findings, the new study - based on analysis of more than 500 million pages - found that the World Wide Web is fundamentally divided into four large regions, each containing approximately the same number of pages.

The findings further indicate that there are massive constellations of Web sites that are inaccessible by links, the most common route of travel between sites for Web surfers.

Developing the 'Bow Tie' Theory explained the dynamic behavior of the Web, and yielded insights into the complex organisation of the Web. These discoveries will help computer scientists better understand the structure of the Internet, and lead to new technologies and design advances that will speed and simplify e-business.

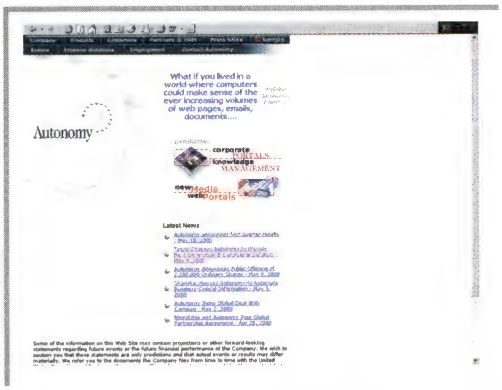
audiohighway.com Tops 8 Million

audiohighway.com at **`www.audiohighway.com`** generated more than 8 million total online visits in April 2000 up from 7 million total online visits in March 2000.

In addition, PC Data Online ranked audiohighway.com 392 among the most frequently visited Web sites on the Internet for April 2000.

audiohighway.com, has built one of the largest and most diverse libraries of free audio content for consumers on the Internet, making it one of the top choices for consumers to listen online.

Tesco Chooses Autonomy for Virtual Shopper


What if you lived in a world where computers could make sense of the ever increasing volumes of web pages, emails, documents....

Some of the information on this Web Site may contain projections or other forward-looking statements regarding future events or the future financial performance of the Company. We wish to caution you that these statements are only predictions and that actual events or results may differ materially. We refer you to the documents the Company files from time to time with the United

Autonomy at **<www.autonomy.com>** has announced that Tesco at **<www.tesco.net>**, the biggest Internet grocer in the UK, has purchased Autonomy's technology to power the next generation of its online shopping service.

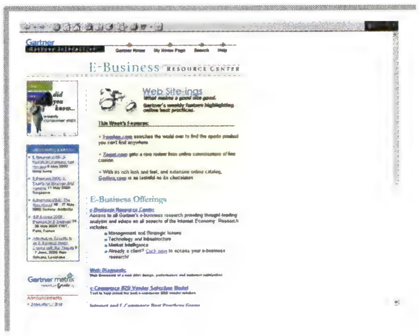
Tesco will use the technology to automatically manage products across its catalogue, as well as provide advanced personalisation, through both personal computers and mobile phones, for customers using the tesco.com site.

Tesco will use Autonomy's technology to create personal shopping assistants on the Web, as a way of suggesting products and services that are appropriate to customers' needs and interests.

The technology will understand customers' interests automatically as they interact with the content on the site, providing them with interesting and appropriate product suggestions and promotions, whenever they are online.

For example, beer connoisseurs will receive news of the latest continental lagers or real ales, chocolate addicts will be shown the latest confectionery, and vegetarians will avoid the latest meat promotions - without the need to fill in online forms specifying user interests.

Gartner.com Launches Web Site-ings


Web Site-ings

What makes a good site good.

Gartner's weekly feature highlighting online best practices.

With its rich look and feel, and extensive online catalog, Godiva.com is as tasteful as its chocolates.

E-Business Offerings

Access to all Gartner's e-business research providing thought-leading analysis and advice on all aspects of the Internet Economy. Research includes:

- Management and Strategic Issues
- Technology and Infrastructure
- Market Intelligence
- Already a client? Click here to access your e-business research!

Gartner Group has launched Web Site-ings at **<www.gartner.com/ebusiness>**, a new weekly Web content feature that highlights online best practices using Gartner's proprietary Web Evaluation Tool.

Web Site-ings is designed to deliver practical advice to technology, business, and new media executives charged with the responsibility for their Web sites' effectiveness. The proprietary Web Evaluation Tool represents a detailed methodology to assess and weigh the many contributing features of good Web sites.

Specifically, the tool articulates value-generating elements in site design, site functionality, and creating customer value, and offers industry-specific criteria for more than 20 industries.

Web siteforFREE.com and freeInternet.com Combine

Web siteforFREE.com at **<www.siteforfree.com>** is to make its Web site development software available to freeInternet.com's registered users at **<www.freeInternet.com>**. FreeInternet.com is the world's leading free and anonymous Internet service provider.

The agreement enables approximately 2.2 million freeInternet.com users to take advantage of Web siteforFREE.com's e-commerce opportunities and small business services.

Users will be able to build, access, maintain, and expand their Web sites online. Fusing it all together is Web siteforFREE.com's online education center which offers all the assistance needed to develop a Web site.

NetRadio.com Attracts Record 2.9 Million Users

netradio.com
the net generation of radio
Listen. 120 programmed music channels.
LISTEN UP
SUBSCRIBE
20% OFF
TODAY'S TEN
portfolio

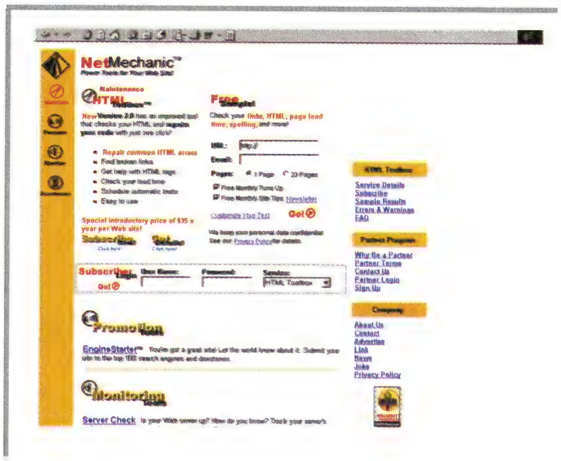
NetRadio.com an Internet broadcaster at **<www.netradio.com>** claims that 2.9 million unique users accessed at least one of NetRadio.com's online offerings during March, including its Web site content, listening page, and Windows Media Player or RealPlayer content streams.

The company also announced that more than 2.5 million unique listeners accessed NetRadio.com's Internet broadcast services in March. This is a record audience figure for NetRadio.com, representing an increase of approximately 87% during the first quarter of 2000.

NetRadio.com is a leading broadcaster of originally programmed audio entertainment over the Internet. NetRadio.com's has more than 100 channels of music and information on demand, 24 hours a day, seven days a week.

The site connects with music enthusiasts through 15 interactive music communities ranging from Jazz, Modern Rock and New Age to Vintage Rock, Country and Classical.

NetMechanic Launches HTML Toolbox 2.0



NetMechanic at **<www.netmechanic.com>**, a leading independent provider of online Web site maintenance, has launched a new tool called HTML Repair. This service is a new addition to HTML Toolbox and a primary component to the new Version 2.0 of HTML Toolbox **<www.netmechanic.com/info/toolbox.htm>**.

This is the only product on the market that will both diagnose HTML code problems and, at the user's direction, repair them. The HTML Repair service will evaluate up to 400 pages of any site, alerting the user to existing and potential problems, then recommending solutions.

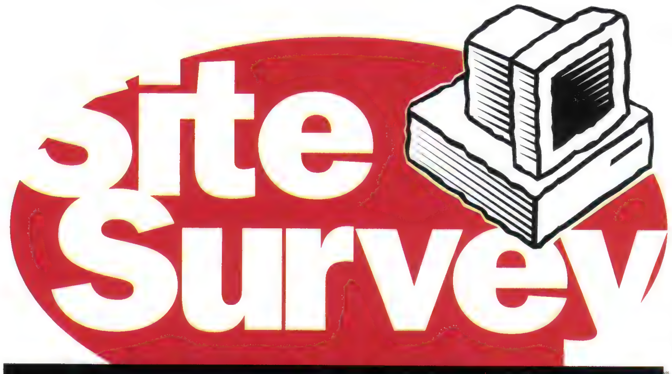
This online service is safe and allows the user to choose whether to implement the repairs. Customers continue to access the user's site while NetMechanic's tools test and repair the pages that can later be uploaded without any down time.

HTML Repair and all HTML Toolbox - Version 2.0 tools can be used on an existing site or to identify and fix errors on a new site while it's being designed.

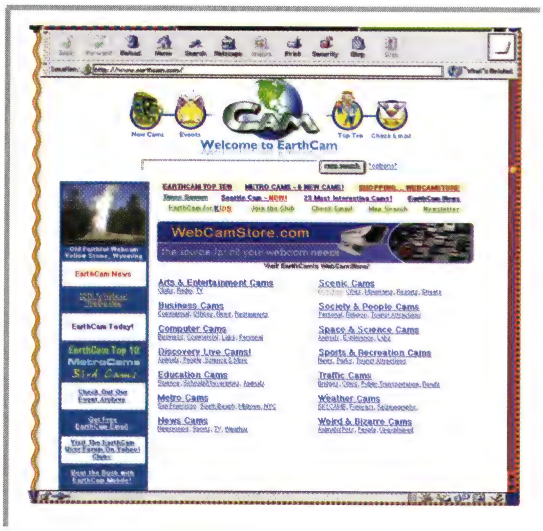
Coupled with NetMechanic's other promotional and monitoring services; NetMechanic is a one-stop resource for all Web site maintenance needs.

A recent report by Jupiter Communications suggested 46% of users have left a preferred Web site because of a site-related problem.

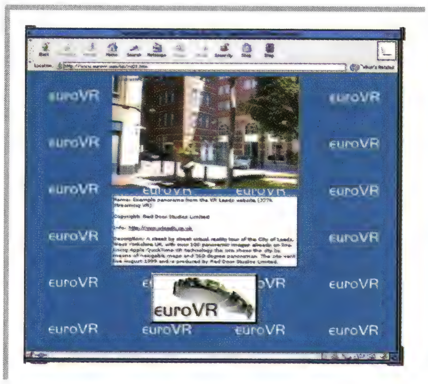
With NetMechanic all Webmasters, from the novice to the expert can avoid potential visitor disasters due to site errors.



The months destinations

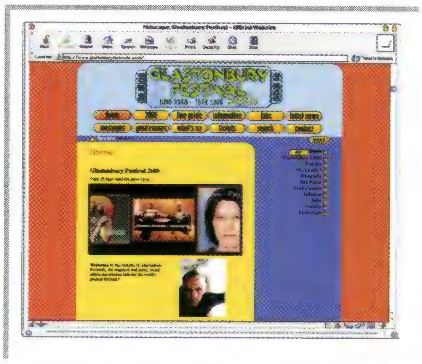


There are quite literally thousands of Webcams hooked up to the Internet, but finding them all is a bit of a problem. One site that aims to help is EarthCam, at **<http://www.earthcam.com>**, where all Webcams it can find are listed in a searchable format. Just type in the name of the place you want to check, and if there's a Webcam there, EarthCam will show you.

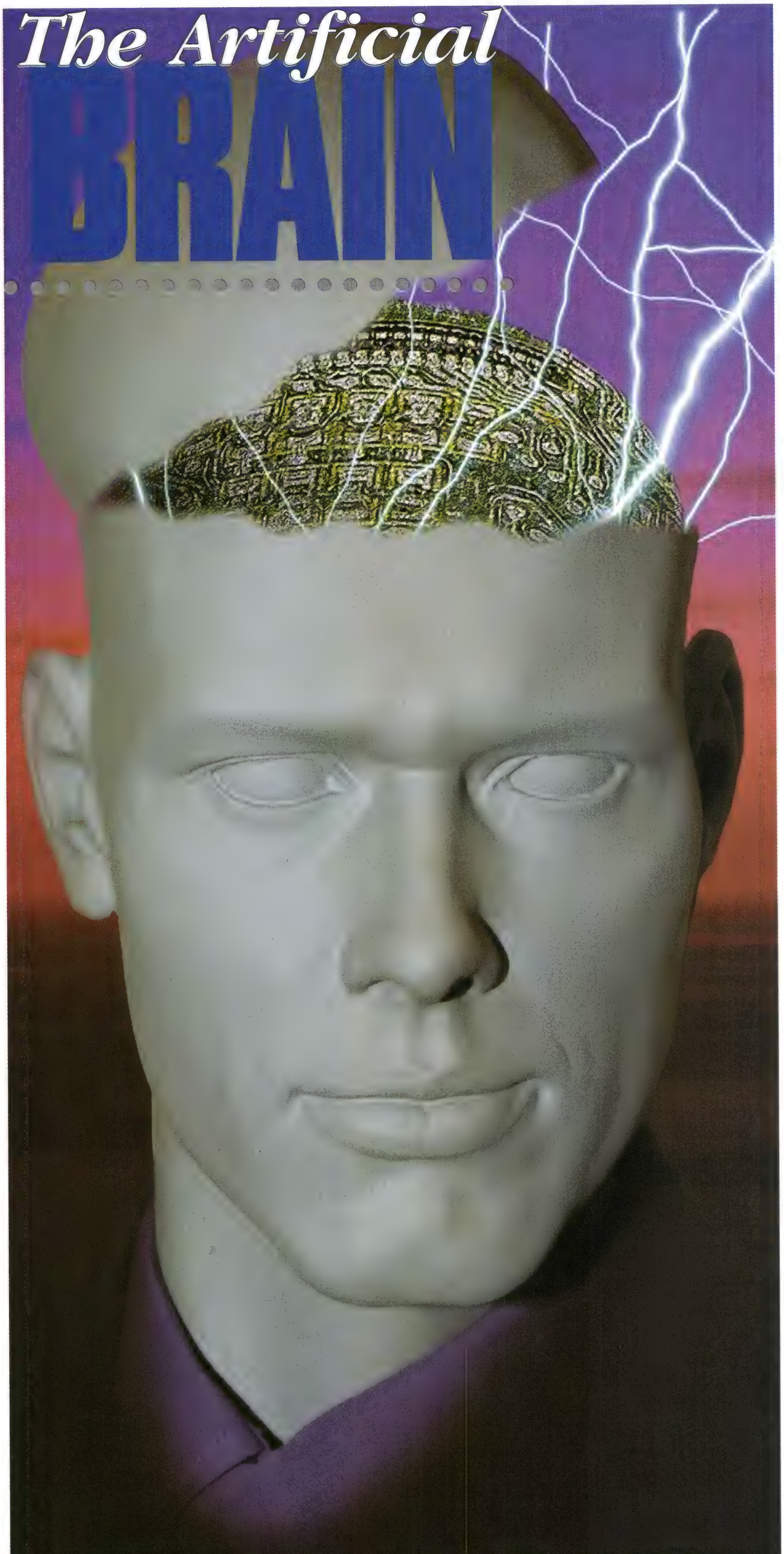


While Webcams are one thing, panorama views of places on the Internet are another. Euro VR, at: **<http://www.eurovr.com>** lists virtual reality panoramas in an easily accessible manner. Panoramas are in QuickTime VR format, which allow you to scroll around the panorama interactively. To use the site, you'll need Apple QuickTime software. If you haven't already got it, QuickTime is available free from Apple Website, at: **<http://www.apple.com/>**.

Join the mud and glory brigade online this year, from 23 to 25 June, but leave your wellies behind. This year's Glastonbury Festival is taking the Internet plunge, at **<http://www.glastonburyfestivals.co.uk>**. Surfing the virtual concerts beats plodging in the real mud anytime. Only the murky atmosphere's missing.



The Artificial BRAIN



David Clark discusses how the latest artificial intelligence systems mimic the behaviour and structure of the human brain, and looks at the principles behind the 'artificial brain'.

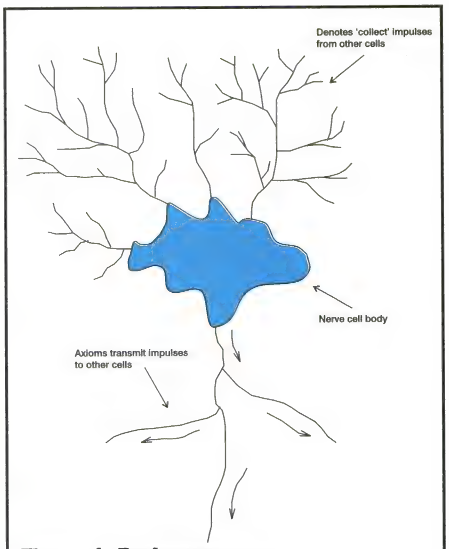

Denotes 'collect' impulses from other cells
Nerve cell body
Axioms transmit impulses to other cells

Figure 1. Brain neurons

Introduction

The human brain is a remarkable device. Consisting of around ten billion cells each of which connects to many, typically 6000, others (see Figure 1) it is a network of unimaginable complexity.

However, it is also remarkably organised, both in terms of how different regions have specific roles but also in levels of function, a hierarchy that corresponds to how the brain has evolved over many millions of years. Manipulating the brain has been a staple of science fiction for many years, from Doctor Who style aliens consisting of brains living in vats of nutrient, through Hammer Horror head transplants to the fully functioning androids virtually indistinguishable from humans of more slick sci-fi films. Perhaps part of the fascination is the fact that the human brain perhaps uniquely possesses - awareness of its own existence and its limited life span. Added to this is the poignancy of the apparent waste of the loss of knowledge and experience that disappears with each generation.

But medicine and engineering have some more immediate and perhaps more noble concerns and requirements for the study of the brain and artificial intelligence. Knowledge of the working of the brain, memory and intelligence can give help with learning, and problems with dyslexia for example. It might help in the development

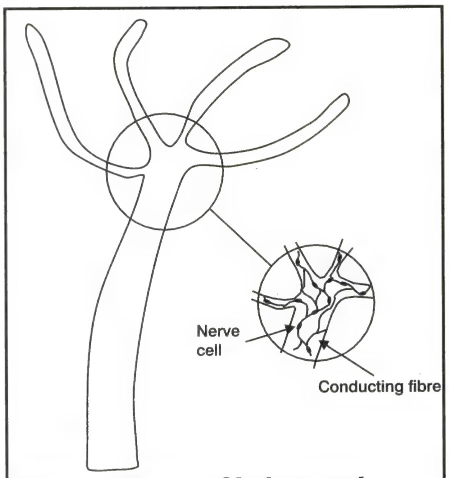


Figure 2. Diagram of hydra neural network

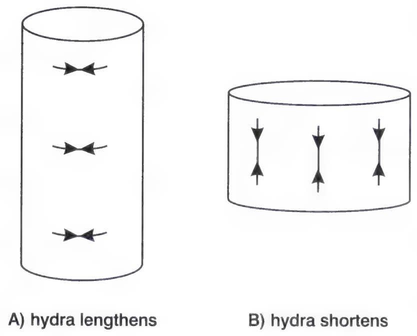


Figure 3. Diagram of hydra muscle action

of more refined and even safer anaesthetics, and in the understanding and treatment of degenerative diseases such as Alzheimer's and Parkinson's and those caused by infective agents, for instance bovine spongiform encephalopathy (BSE) and the human form Creutzfeld-Jakob disease (CJD). 'Intelligent' systems should provide more effective methods of operating equipment in hostile environments, for example, and aid more mundane everyday tasks that involve interacting with computer based applications.

Evolution

Fifty years ago the computer pioneer Alan Turing devised a test that would give a measure of how intelligent an artificial intelligence was. This was basically a measure of how long it took a human observer to tell whether it was a human or a machine that was giving responses to a set of questions asked - the test usually didn't take very long! Earliest artificial intelligence programs were more or less systems for giving a pre-determined output from a combination of inputs based on examination of the input according to a set of fixed rules, essentially a fixed logic system. This soon developed into a system that involved 'fuzzy' logic. 'Fuzzy' logic output is based on probability or likelihood and so allows the possibility of definitely true, probably true, might be true, unlikely to be true, definitely not true etc., rather than the hard output of a simple 'true' or 'false' value. The next generation of artificial intelligence is now being modelled on the best device available so far for exhibiting intelligence, the human brain.

To understand how the brain works it is useful to look at how it evolved. The most primitive organisms to evolve were single cell organisms such as the amoeba, where the single cell obviously has to perform all the functions necessary to live. This includes absorbing nutrient, and digesting and metabolising it to give energy and material to enable other processes such as movement, growth and cell division. As organisms evolved and became multi-cellular there came a need for a form of communication between the different types of cells. The hydra for example, a tube-like animal with tentacles that lives in ponds, lakes and rivers has a neural network (see Figure 2).

The organism has two types of muscle-like cells one of which acts longitudinally thus shortening the body and the other

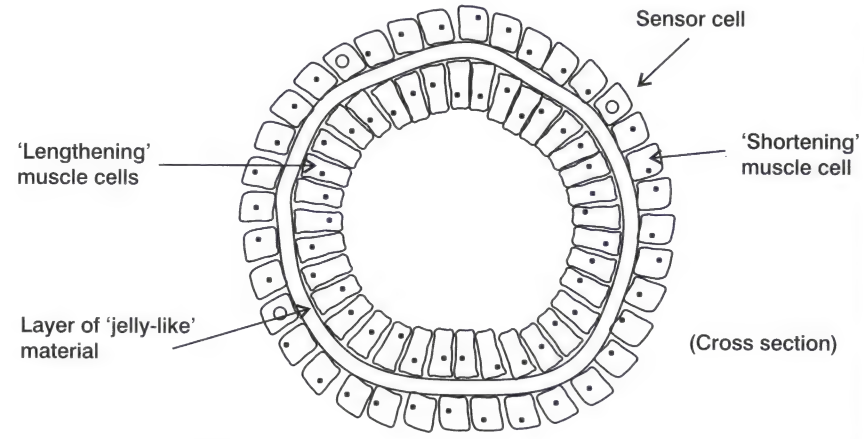
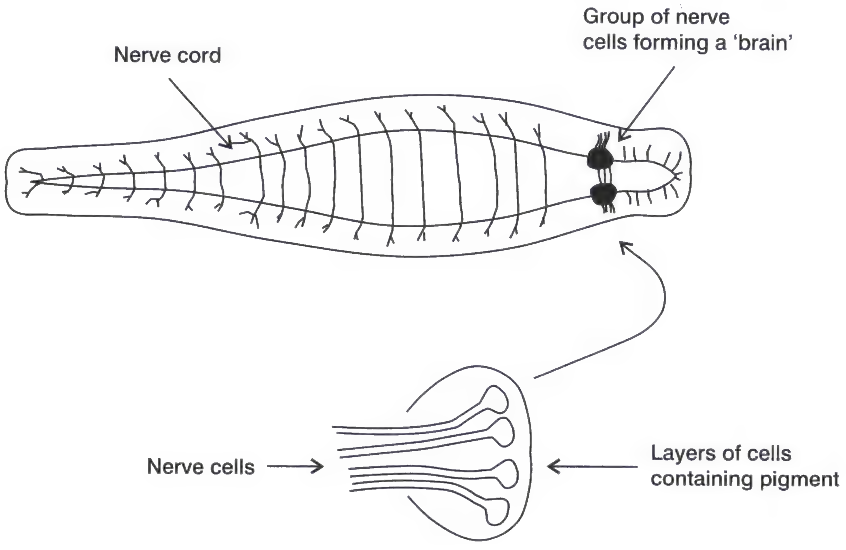


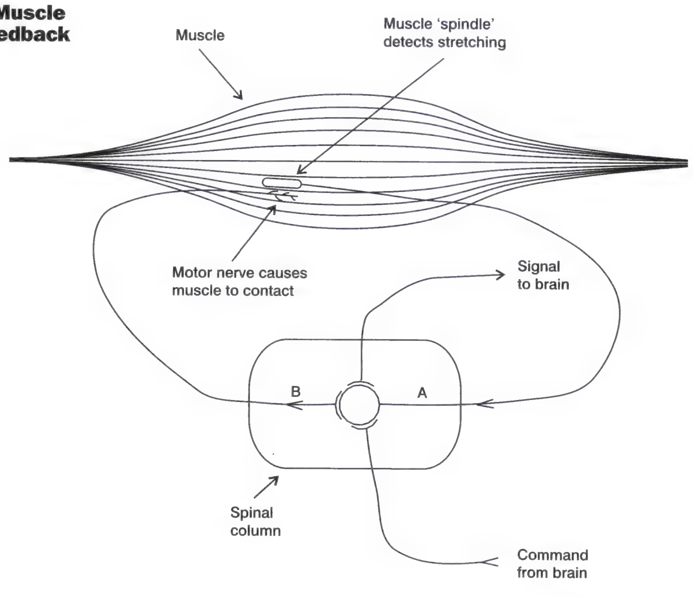
Figure 4. Diagram of structure of hydra body


Group of nerve cells forming a 'brain'
Nerve cord
Nerve cells
Layers of cells containing pigment

The nervous system of the flatworm shows the beginnings of specialised organs. These are a nerve cord from which other nerve fibres emanante, a collection of nerve cells acting as a 'brain' and a 'eye', a collection of a few nerve cells contained with a pigment cup which are triggered by light which also link to the brain.

Figure 5. The flatworm nervous system

Figure 6. Muscle control feedback


Muscle
Muscle 'spindle' detects stretching
Motor nerve causes muscle to contact
Signal to brain
B
A
Spinal column
Command from brain

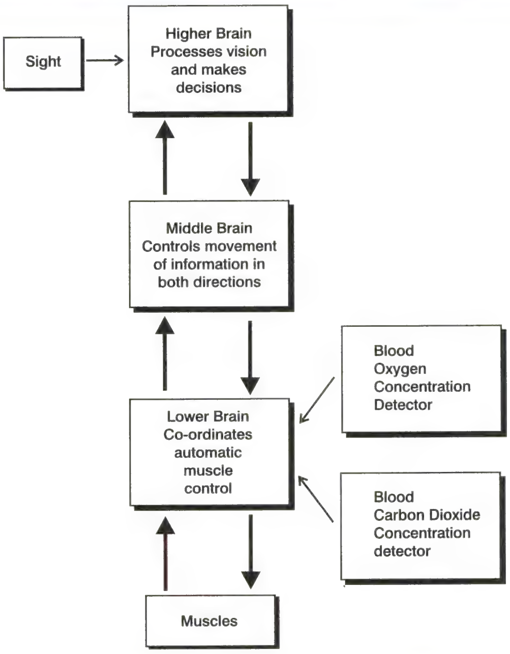
For automatic reflexes the signal travels directly from A to B with no brain involvement. Other signals 'tell' the brain what is happening, and give 'commands' for voluntary actions which 'over-rule' automatic actions.

Brain Hierarchy

Breathing is a good example of demonstrating the hierarchy of processes in the brain. Normally we are not aware of the fact that we are breathing. Detecting systems around the body 'monitor' the amount of oxygen and carbon dioxide in the blood; the lower part of the brain automatically controls the muscles of the chest wall and diaphragm and we automatically breathe in and out. The middle 'level' of the brain passes this information up to the higher part of the brain so that we are aware of breathing if we stop and think about it. The higher part of the brain processes sight and might tell us for example we are about to dive into water. This then causes a conscious decision to take a deep breath and hold it as we jump. In this case the command is passed in the opposite direction from the higher brain down to the systems that co-ordinate the movement of all the muscles involved and make them act correctly.

This outer part of the brain is a complex 'high-level' neural network, and different regions are responsible for different functions in other words the brain can be thought of as having a 'modular' structure. For example there are 'modules' associated with vision, hearing and so on. The rest of the upper brain, called the association cortex, appears to have areas responsible for less definable functions such as speech and pattern recognition, and the remainder is responsible for more abstract attributes such as thought, memory and conscious behaviour. This indicates that these attributes are not mere functions of individual modules but are due to the hugely complex 'interconnectedness' of the modules.

Figure 7. Brain Hierarchy


Sight
Higher Brain Processes vision and makes decisions
Middle Brain Controls movement of information in both directions
Blood Oxygen Concentration Detector
Lower Brain Co-ordinates automatic muscle control
Blood Carbon Dioxide Concentration detector
Muscles

which acts laterally thus lengthening it (see Figure 3).

These muscle-like cells connect to the neural network. The animal additionally has sensory cells that respond to light and which are also connected to the neural network. When stimulated these sensory cells trigger the neural network, which then causes the co-ordinated contraction of the muscle-like cells and hence movement towards the light source. (Figure 4 shows the structure of the hydra body.)

More complex organisms such as the flatworm have even greater levels of organisation, possessing an 'eye', nerve cords and small collections of nerve cells acting as a 'brain'. Flatworms were in fact the first organisms in the evolutionary process to develop an identifiable 'head' region containing a sense organ and a 'brain' from which a definable nervous 'cord' connected the nervous 'system' to the rest of the body. See Figure 5.

Development and increasing complexity beyond the flatworm has ultimately led to the insects, probably the most successful class of organism in terms of numbers and adaptation to particular environments. Another route of evolution occurred however, via a creature which was similar to the flatworm but which had a different embryo stage, and this led to the evolution of creatures with a spine to carry the nerve cord and a skull to protect their larger brain. Ultimately of course, in brain development terms, this has led to humans. Interestingly, the structure and activity of the brain and spinal cord reflect the evolutionary process in its hierarchical formation. Mimicking this structure is leading to the most successful attempts so far to produce artificial intelligence.

The Reflex

At the base of the hierarchy is the most simple nervous system activity, which involves no intelligence at all. This occurs in the spinal cord part of the nervous system. For example a sensory nerve built into the muscles called a muscle spindle sends out a signal when the muscle stretches. The far end of this nerve is in the spinal column where it ends in a synapse. (The synapse is a junction between nerves. The electrical impulse of the first nerve is converted into a chemical 'message' which crosses the gap between the nerves and triggers a further electrical impulse in the second nerve. The advantage of this system over a direct electrical connection will be seen in the 'Synapses' section.) The nerve signal crosses the synapse and triggers the spinal column end of a motor nerve. The far end of the motor nerve is connected to the muscle and the signal reaching this end causes the muscle to contract. Thus this is a sensitive feedback system that enables the muscles to remain in just the right amount of tension in order to stand upright for example. This system also enables an effectively instantaneous response to pain for instance by causing an involuntary withdrawal of say the hand from a sharp object.

However the sensor - synapse - muscle signal path doesn't occur in isolation. The synapse is also connected to other nerve cells, each of which can influence the activity of the cell to which it is connected. These communicate information about this simple reflex activity to the next level up in the hierarchy, the lower brain, and also receive 'commands' from the brain, enabling conscious, or deliberate, activity. Figure 6 shows this.

The lower brain co-ordinates all the information about muscle tension and position etc. and hence regulates coherent body movement. It is the equivalent of the neural network of primitive organisms, and we are unaware of its activity. The 'next level up' in the hierarchy is the mid-brain. In primitive creatures this region processed the information from the light sensors, or primitive 'eyes', and communicated it to the rest of the nerve system. In humans the processing of sight has moved to the higher brain along with all the other senses. Nevertheless, the mid-brain still controls the communication of information between the lower brain and the part of the brain that in humans contains 90% of the total number of nerve cells in the whole of the body's nervous system. This is the upper brain, or

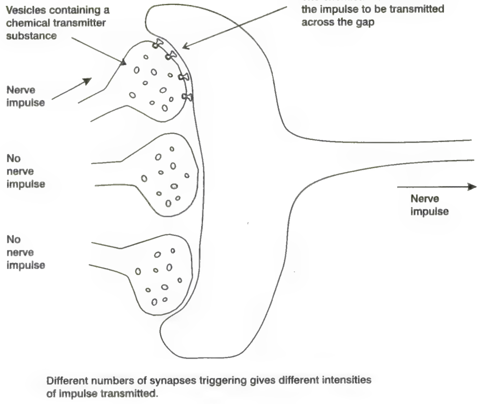

Vesicles containing a chemical transmitter substance
The chemical transmitter causes the impulse to be transmitted across the gap
Nerve impulse
No nerve impulse
Nerve impulse
No nerve impulse
Different numbers of synapses triggering gives different intensities of impulse transmitted.

Figure 8. The synapse

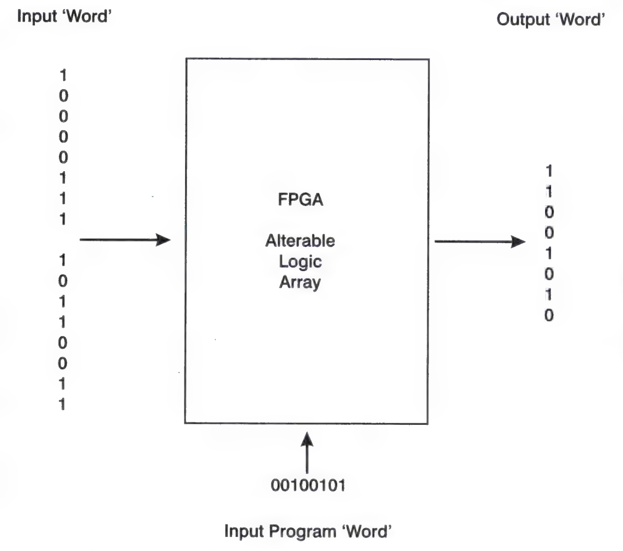


Figure 9. Principle of the FPGA

forebrain, or cerebrum. It is the part of the brain where it is believed all conscious activity occurs, thought, decision-making, memory, learning, awareness, language, imagination, 'inner visualisation', creativity, where in fact consciousness itself 'exists'. See the box text 'Brain Hierarchy' for an example of this.

Synapses

Here another aspect of the connections between brain cells, and nerve cells in general, needs to be considered. These connections are mediated by the synapses. The electrical impulses pass between the nerve cells via a chemical 'messenger' and this allows the link to be more than a simple on/off digital-like event in that it can vary in intensity and hence have a 'fuzzy logic' type response. See Figure 8.

This allows a much greater level of variability and complexity between all the many nerve interconnections. What is more there is an even greater level of complexity to be considered. The 'messenger' chemicals, or neurotransmitters, involved in the synapses act only locally at that synapse. However, there is another neurotransmitter at work in the brain. This is nitric oxide and it is such a small molecule that it can pass easily through cell membranes. When it is present it increases the amount of normal neurotransmitter released when a nerve triggers. Furthermore because of its ability to pass through cell membranes it can act on nerve cells a long way from the cell that released it. This adds another order of complexity and sophistication to the 'interconnectedness' of the cells of the brain.

So given this high level of network interconnectedness how does artificial intelligence even attempt to simulate such a complex system? Latest developments in artificial intelligence are looking more and more to mimicking not only the biological functioning and structure of the brain, but also the fundamental process by which intelligent behaviour developed, genetic evolution. And just as in a biological system the intelligence and the brain modules are inseparable parts of the whole brain.

The Artificial Brain

The basic artificial brain module corresponding to the module of the biological brain is a Field Programmable Gate Array (FPGA). See Figure 9.

This is a device that has a number of digital inputs and outputs. For example's sake assume sixteen inputs and eight outputs. The series of 1s and 0s or 'word' that appears on the output for a given 'word' on the input is determined by how the internal logic of the FPGA is configured which itself is pre-determined by a set of instructions loaded onto another 'input'. For the sake of simplicity assume this too is a single 8-bit 'word'. The ability to modify the output that appears for a given input allows each module to be built into a system that can 'learn' and modify its behaviour so that it gets better and better at the role for which it is intended. This is done by allocating a score (in a similar way to a fuzzy logic output has a probability value) as a measure of how well the module has performed its task, ie how close the actual output of the FPGA is to the desired outpu for a correct result. The first time it performs the task it is likely to be fairly poo at it. The score will be low. Another 'word' i then put on the programming input and th task performed again. If the score is even worse the programming input word will be discarded and the original word kept. Then another one is tried. If the score is better the new word is kept and the original one discarded. Again another one is tried, and the word giving the best score is kept each time; with each 'generation' of brain module behaviour the module will improve its performance. Furthermore if the task is changed the module will automatically start to 'learn' its new task thus giving a flexible system.

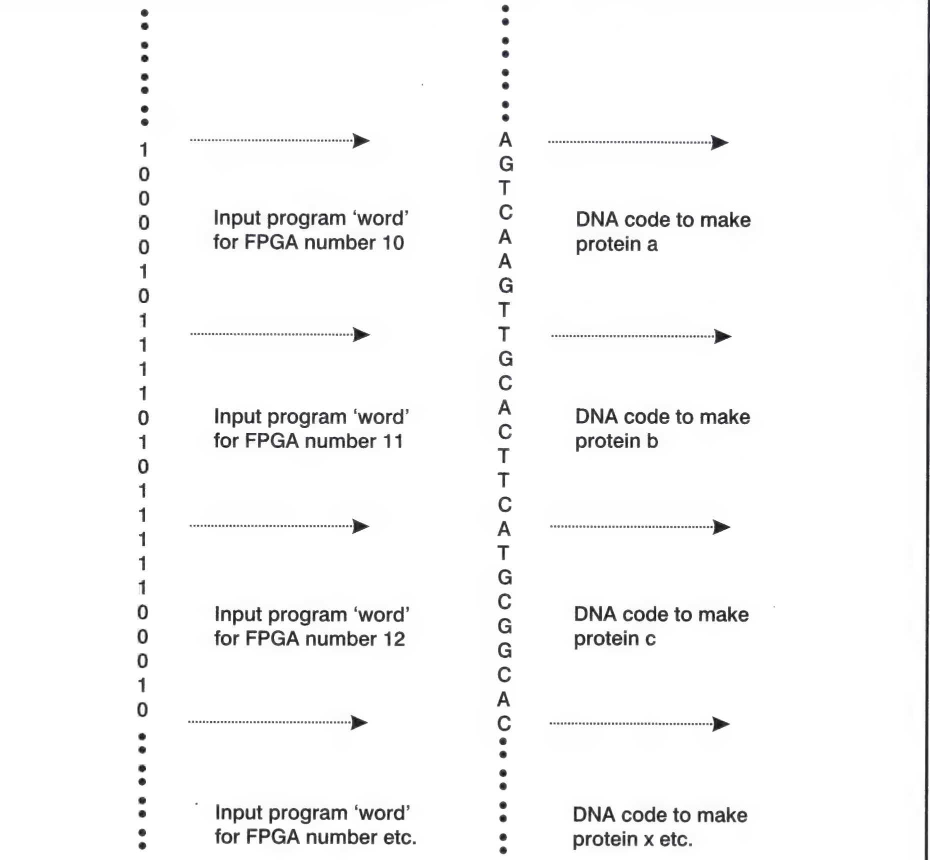
An example of one of the functions of a real brain module is pattern recognition, fo example recognising faces. Simplifying this for example's sake to the recognition of a square, the set of optical sensors that form the FPGA input might give an input word value of:

0000 0110 0110 0000

corresponding to 'seeing' a square ie:

0 0 0 0
0 1 1 0
0 1 1 0
0 0 0 0

The output word from the FPGA that is desired for when 'there is definitely a square


1
0
0
0
0
1
0
1
1
1
1
0
1
0
1
1
1
1
0
0
0
1
0
Input program 'word' for FPGA number 10
Input program 'word' for FPGA number 11
Input program 'word' for FPGA number 12
Input program 'word' for FPGA number etc.
A
G
T
C
A
A
G
T
T
G
C
A
C
T
T
C
A
T
G
C
G
G
C
A
C
DNA code to make protein a
DNA code to make protein b
DNA code to make protein c
DNA code to make protein x etc.

The string of 1s and 0s that control the 'behaviour' of the FPGAs is analogous to the human chromosome that controls the cell manufacture of proteins, many of which are enzymes that control cell behaviour.

Figure 10. The electronic chromosome

xactly in the centre of the field of view' ould be say 255, the maximum value of an -bit word. 'Seeing':

0 0 0 0
0 0 0 0
1 1 0 0
1 1 0 0

ight give an output of 200 corresponding o 'there is likely to be a square in the field f view' and:

0 0 0 0
0 0 1 0
0 0 1 0
0 0 0 0

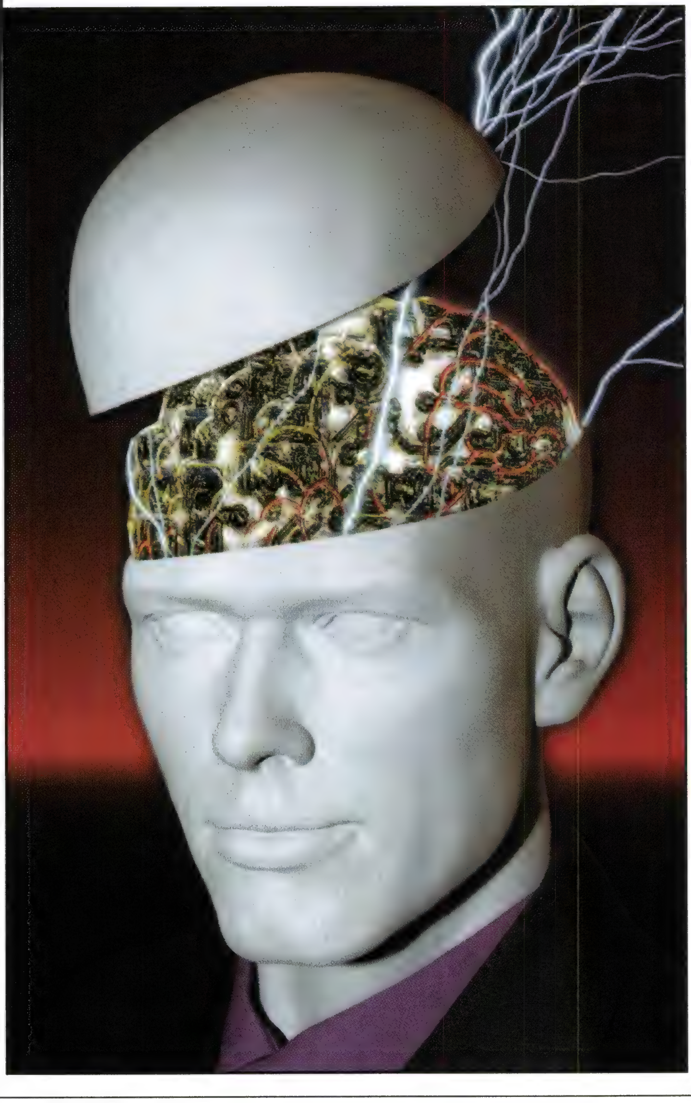
ight give 10 to indicate 'there is omething there but it's not a square' and:

0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0

ight give 0 to indicate 'there's nothing in he field of view'. Any of the last three results' might for example trigger another FPGA to control output actuators to 'look' around until something comes else comes into the field of view. If the word on the program input didn't give these results, another word could be tried that see if that gave closer to the required output and if it did then that word would be kept. The artificial brain module is therefore 'learning' under the control of the word on the 'programming' input.

One 'artificial brain' already developed has several FPGAs all dedicated to individual tasks, all working in parallel and independently, ie at one level in a hierarchy. The next level in the hierarchy is to have all the FPGAs interconnected and so influencing each other's behaviour. But just as each individual FPGA's behaviour is controlled by its input programming word the interconnections between the FPGAs can also be changed by an input programming word. The artificial brain can then 'learn' to perform a complex task that needs the 'co-operation' of all the individual FPGAs in a complex system of interconnectedness in a way that matches that of a real brain. (This mimics the biological learning of activities where the connections between the neurons involved are strengthened when a good result is achieved, and disappear when it is not.) In computer simulations of artificial brains the FPGAs are replaced by software models. An additional advantage of software implementation is that the activity of the NO neurotransmitter can also be mimicked to give an even closer imitation of a biological brain. And just as in a real brain there is no 'top level' system controlling the lower levels. The artificial brain has its own activity that is independent of outside influence. In a way it has a 'life' of its own that is too complex to predict.

In reality of course there is a 'higher' influence. Someone has to decide what the task is that the 'brain' is being set to do, and to provide the yardstick by which the score for how well it is doing that task is determined. But within that limit the brain's behaviour is autonomous.



Electronic Genes

Another fascinating concept that this structure allows is that of the 'electronic gene', several of which might make up an electronic 'chromosome' (see Figure 10).

In an artificial brain of say one hundred FPGAs control of the brains activity is completely determined by the one hundred input program words. This string of 1s and 0s one hundred words long is analogous to the string of Gs, Cs, As and Ts (the guanine, cytosine, adenine and thymine nucleic acids) that make up the DNA of a chromosome that completely controls the behaviour of biological cells. Just as a particular sequence within the chromosome is a gene that controls the production of a protein or enzyme that determines a particular structure in, or activity of, a biological cell so the particular word (gene) within the string of words (chromosome) controls a particular activity of the artificial brain. The discarding or keeping of a particular word to improve the activity of the module is analogous to the process of evolution in adaptation to environment - good genes are selected and 'bad' ones are rejected ie die out.

This gives rise to two more incredible possibilities. Any particular 1 or 0 on the electronic chromosome can periodically be randomly changed (which can be outside the control of an operator) - an electronic mutation. If this random event leads to an improved performance it will be kept - the artificial brain will automatically evolve from 'generation' to 'generation'. Even more incredible is the possibility of a form of electronic breeding or cloning. A particular region of 1s and 0s on the electronic chromosome could be swapped or intermingled between two artificial brains to give an 'offspring' with some characteristics of both 'parent' brains. Or a particularly successful string of 1s and 0s could be copied to another artificial brain to give identical behaviour.

There is one thing that is still missing from this artificial intelligence however. That is an inherent goal or purpose. The system can learn from errors and change behaviour indefinitely until a correct 'result' is achieved, but the initial goal has to be given to the intelligence for it to work on. Nevertheless the possibilities are amazing (or terrifying depending on your point of view), and the future holds the prospect of devices with a form of machine 'consciousness'.

Conclusion

Artificial intelligence is already widely used in software fields as diverse as disease diagnosis, financial market modelling, project planning, speech recognition, natural language interrogation of complex databases and safety critical software development. In the hardware field of applications the inputs of the FPGAs can be connected to sensors and the outputs to motors, actuators etc. This gives intelligent systems, machines and robots, though in practice very different to the androids of science fiction. Nevertheless the humanoid-style robot is a goal of many developers and simple 'personal robots' have featured in Electronics & Beyond's News Bytes pages. So working towards the goal of an autonomous mechanical 'intelligent being' in a small series of steps will very likely provide useful devices, knowledge and techniques that will enrich 'real' life. It certainly provides plenty of food for thought for 'real' intelligence!

Towards a SAFER FUTURE

Douglas Clarkson

Introduction

As we try to map out the options for the future, we can be sure that we will have increasingly available data across a broadening range of subjects and topics. There is of course great interest in trying to use this information on as broad a range of fronts as possible. The very core of the Internet operates on the basis of efficient search engines to find specific selected categories - so this is an example of developing a mechanism to utilise a resource.

The vast effort currently in place to direct and control our spending on the net is an example of corporate skill working on the individual. What hopefully will evolve, will be information systems that operate for the single benefit of the individual - by lowering the 'life risk' of the individual through lifestyle modification. On a more general topic, our increasingly complex infrastructure needs to be optimised in its design to present a minimum of risk to those who live and work within it. The two strands can be expected to develop in parallel in the future.

As social patterns alter rapidly, prompted by technological change, there is also increasing suspicion of new processes. The fear of genetically modified products is a manifestation of fear of a future over which we feel we have less and less control. Perhaps we intuitively understand that there is a very good reason why the gene pool of the world is the way it is and it is not worth the risk to tinker with this delicate 3500 million year old mechanism.

We can expect, however, an increasing awareness of the 'risk' of doing anything and to actively look for service providers that will be able to provide answers in respect of lifestyle choice. This confirms an increase in awareness that the cost of services and goods may not be the prime concern of consumers. There is also the strand of purchasing goods and services from non- polluting sources.

As the Internet age develops, it will be most interesting to observe how it changes perception of risk in society and more importantly perhaps how it is used to minimise the risk to the individual from all the processes that will constitute life in the 21st century.

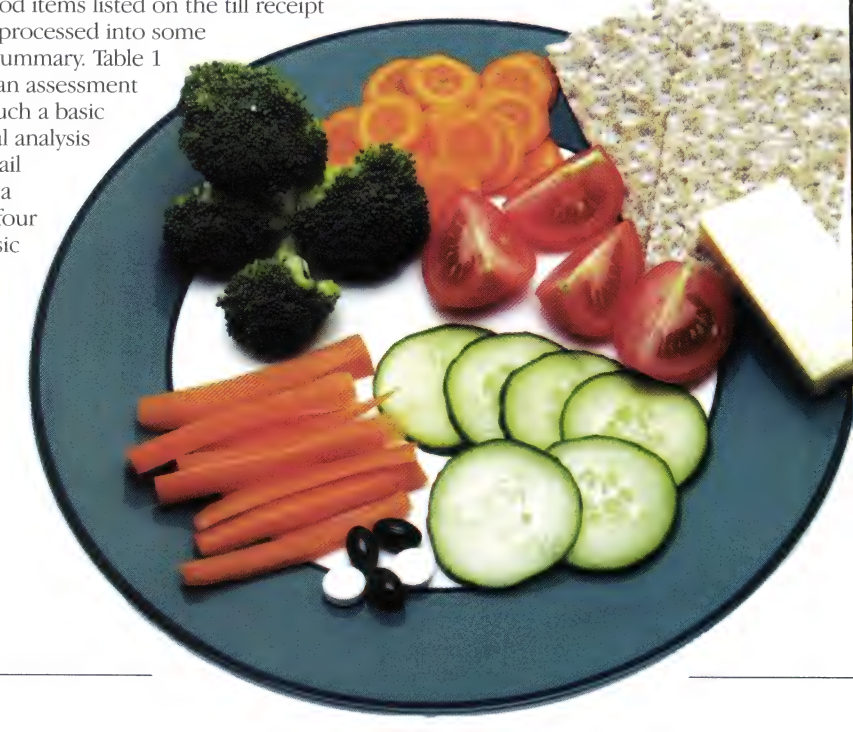
Living with Risk

We live at a time, also, where the increasing industrialisation and technological developments are changing the dynamics of risk factors in society. This is also happening in such a complex way that it is almost a full time occupation keeping track of new information let alone remembering all that has been researched previously.

There is also the perception that we have not even have caught up with implementing what we already knew to be safe living style before technology has given us yet more options to choose from and with not all of these potentially healthy. Yet in some way there is a process of 'diffusion' of information into society regarding the risk factors that are now current. The obvious reality of this process of diffusion is that while there is awareness of what the risks are, the perceived relative importance of these risks is often out of proportion to actual risks. Some mechanisms of providing information are under our very noses.

Diet: Nutritional Profiling

Diet, in its broadest context plays a significant part in determining the health of the nation. As a factor in cancer prevention, it can alter predispositions by as much as 35%. With the migration towards weekly supermarket food purchasing being a firm feature of global shopping, the 'bottom line' has come to mean the cost of the food purchased. At the same time, however, the opportunity is also there to give a basic nutritional analysis of the products thus purchased. Imagine all of the nutritional data of food items listed on the till receipt could be processed into some relevant summary. Table 1 presents an assessment of what such a basic nutritional analysis could entail based on a family of four with a basic calorie input of 2000 calories per individual per day.



Total Individuals = 4		**% Weekl Value**
total calories	56000	105
total fat	560	33
cholesterol	14g	76
sodium	7400mg	88
total carbohydrate	1100g	85
dietary fibre	320g	80
protein	650g	83
vitamin a		60
vitamin c		120
calcium		67
iron		83

Table 1: Format of 'weekly shop' possible nutritional profile of purchasing based on FDA nutritional guidelines (see points of contact).

Based on this assessment, the calorie input is slightly high and the vitamin A inpu is quite low.

In terms of food labelling in the USA, there is a structured approach to label information with Table 1 modelled closely on displayed product data. The active selection of the items displayed in Table 1 are based on ' % Daily Values'. There is of course debate as regards the particular values that represent individuals and family groups. To allocate 2000 calories to every member in a family is not going to include perhaps the very young or the very old. Also, depending on the options available for processing such data, a running history, display of trends etc. is possible, and it could allow trends in food purchase to be monitored.

One of the thin veils in product merchandising is the perception of advantage of the retailer as against that of the welfare of the customer. The recent damning report on the nutritional value of children's 'foods' indicates that supermarkets are quite happy to stock their shelves with food of very dubious nutritional value in an attempt to increase sales but with no real regard in this respect for the nutritional well being of children.

So what we are looking for, is the responsible food retailer who can provide nutritional data at least at point of sale or better on a personal web page which can be more finely tuned to ving independent nutritional advice. It is uite obvious that customers would wish to urchase a greater percentage of their 'food uy' at a facility that supported 'nutritional rofiling' - so from the point of view of the ood retailer, this is indeed a 'win win' tuation.

There would be an opportunity to stablish a 'nutritional profiling' industry ased on the Internet, which could provide ndividuals or families with individual ccount access on behalf of food retailers.

However, the basis of this approach is hat it takes little or no effort on behalf of he food shopper. It is the item code eader/IT of the food retailer that would be nabling the flow of information back to the ustomer. One option is to store the data n a 'smart card' for the customer and where the details can be processed/ eported on terminals within the food store.

It is usually the case that where one leads he others will follow. It is a fair question to sk what supermarket would indeed be willing to present an honest nutritional rofile of the goods that were purchased by ts customers?

Altering the Perception of Road Traffic Accidents

Each year around 5500 people are killed on the roads of the UK. A worrying trend of these statistics relates to increased casualties among children. Across the developed world, in excess of 125,000 people are killed in road traffic accidents each year. RTAs have regrettably become almost an 'acceptable' aspect of modern living.

It is, however, becoming a social custom to mark the location of fatal RTA's with bunches of flowers at both the time of the initial accident and also at anniversaries of the accident. This on the one hand meets the need of the relative to give remembrance of the individual(s) and increases the awareness of the public at large that accidents happen and that driving with care is required.

It might not be obvious, but the image of the car is constantly being re-inforced as an image of personal prestige and independent lifestyle and with little emphasis on the requirement for responsibility on behalf of vehicle drivers. Within a typical terrestrial commercial channel at peak viewing up to three minutes per hour are devoted to car advertisements - reinforcing not just the particular model of the car but the concept of the car as a legitimate extension of individual lifestyle. On a more disturbing note, many of these advertisements provide a focus on children. Is this because they present a more non-questioning, trusting manner?

Local authorities could give increased prominence to RTA's if they posted on the Internet information relating to RTAs involving serious injury or death within their boroughs. The object of such a process would seek to heighten local awareness of traffic risks and would, for example, provide a set of information for school based RTA awareness projects. If such a system were to be linked up nationally, to provide a national resource, it would provide a great wealth of information that could be used to raise awareness of RTA prevention.

St.Cristopher.com

If we consider, another way that information is managed regarding road traffic accidents. In route navigation, the prime concerns relate typically to shortest distance/fastest route. It would be equally relevant to find the route that had the least chance of a RTA based on an available database of such information. As an individual there is little chance of having access to this core information, or even being in a position to utilise it in a sensible fashion. It would be a quantity, however, which would be in some demand. Is there an information provider - a St.Christopher.com of the Internet age, who could provide such as service.

Towards Risk Minimisation

One of the great challenges, is to model and plan for safety within our complex technological infrastructure. Taking a cue again from road transport, car drivers are aware that there are very specific locations where accidents are more likely to happen. This gives a clue that these 'dangerous' black spots have passed from the town planner's drawing board to concrete and asphalt without being identified as a hazard. What is required is a more comprehensive system of risk minimisation.

This could relate, for example, to design of a roundabout, lane change or intersection. There is thus afforded at the design stage of such structures an opportunity to simulate a given segment of road design and model aspects of traffic density, type, and driver competence in order to determine the safest solution.

In the example of the roundabout, we can simulate the traffic flow, vehicle mix, weather conditions, vehicle acceleration, - modelled very closely on observed driver behaviour and get a feeling for quality factors of closeness of approach and collision probability. The computing power of current computers is certainly up to simulating decades of use of such traffic systems. The design selected would presumably be that which could offer the safest operational factor within the set operational budget. This is therefore determining design as an integral part of risk reduction. It is an open notion, therefore, to consider which percentage of RTA's have contributing factors which relate to non optimisation of road infrastructure design.

In the design of a railway train feeding in and out of a main station, an appropriate test facility would be a software facility to simulate say 10 years of train operation. This would entail modelling all of the routine operation of the station, giving allowance for disruption of timetables, mechanical defects in trains, train breakdown, failure in signalling systems etc. and potential driver error. Closer bunching of tracks and signalling systems would, for example, be associated with greater chance of signal reading error. The advantage of such simulations systems, with appropriate probabilities of events taking place, is that

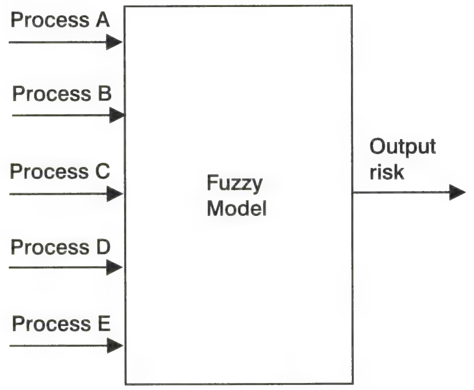


Figure 1: Model of processes that interact to create a risk factor as an output.

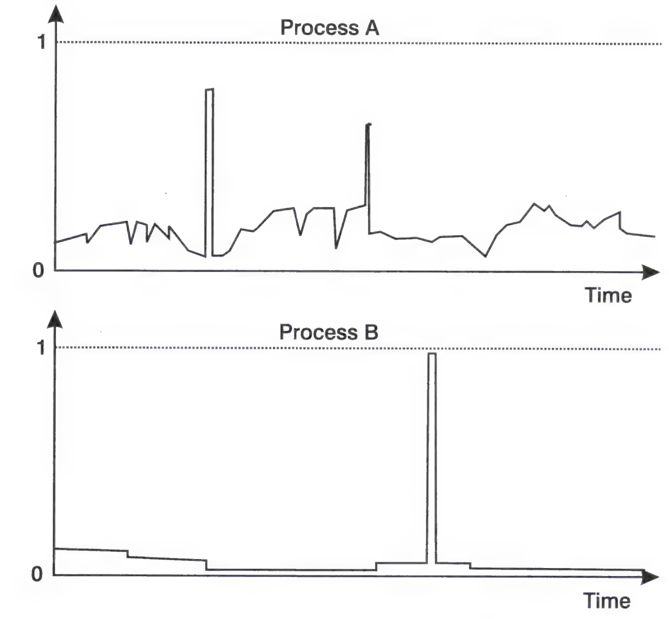


Figure 2: Representation of processes A and B with time.

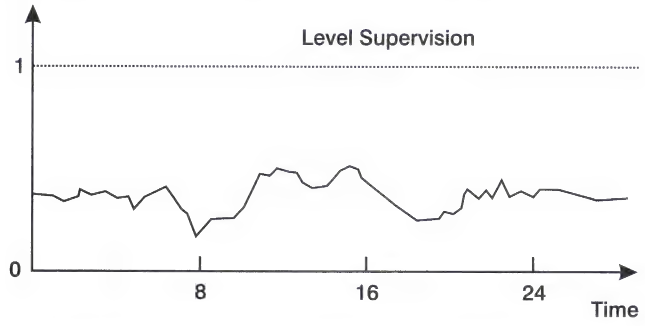


Figure 3: Making input functions 'real': Levels of relative supervision on a shift work installation.

many different configurations of design can be tested as a component of optimising the final design for lowest risk.

Risks Modelling Using Fuzzy Logic

Where risks are relatively well known, based on statistics, we can, however, develop mechanisms to model these factors, and undertake the translation of relative risk into representative probabilities. We are looking therefore for ways and means to model events taking place. One way of understanding how different processes interact is to use Fuzzy Logic. While the conventional Fuzzy Model has so called 'crisp' inputs, such as pressure, temperature etc, when we are trying to model probabilities and risk, and our input functions are themselves reflecting probabilities. They can be considered to vary on an instant by instant basis. The many complexities of modern life, however, make it increasingly difficult to take a situation and unravel the many different components of activity determining the ultimate risk outcome.

This creates the problem, in many ways, of representing a relative risk - one component among several, as a time varying function, which reflects a representative value of the given function. Then there is the task of combining these together as a series of rules to make the combined risk reflect the interaction of specific factors.

We can consider a model of various processes as indicated in Figure 1. In real time each process has a specific unique value so that as inputs we have five independent time varying functions. The next question emerges, how do we combine these independent input parameters to form a single value representing the outcome of risk? The solution is to use Fuzzy Logic and with the rule-based nature of the system description being the main key to the process.

In Table 2, the format of these rules is outlined.

IF PROCESSA is HIGH and PROCESSB is HIGH then ORISK is HIGH

IF PROCESSB is HIGH and PROCESSD is HIGH then ORISK is HIGH

Table 2: Structure of rule based framework of Fuzzy Logic.

The 'fickle' nature of risk can be seen if we take some functions that represents processes A and E as indicated in Figure 2.

The combinational nature of the risk interaction, which typically relates to two factors interacting together, means that we have modelled the risk of random interaction of the two processes.

The actual values of the risk profiles, however, should reflect relative risks based on operational conditions. In Figure 3, for example, we display the level of system supervision on a three-shift system and with better supervision during the main day shift. The Chernobyl disaster, remember, took place when the night shift were on duty.

The process of simulation of such systems requires to be conducted for extensive time periods - reflecting the processes associated with many years of operation.

It is then that some picture of the inherent safety of the system can be resolved as a reflection of some kind of 'infinite' simulation experiment as indicated in Figure 4.

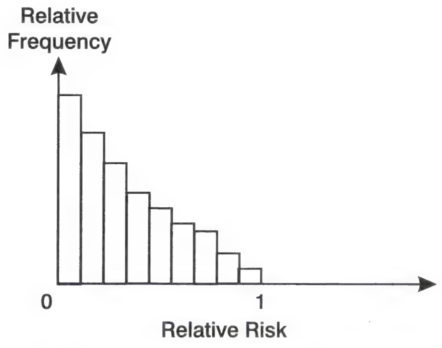


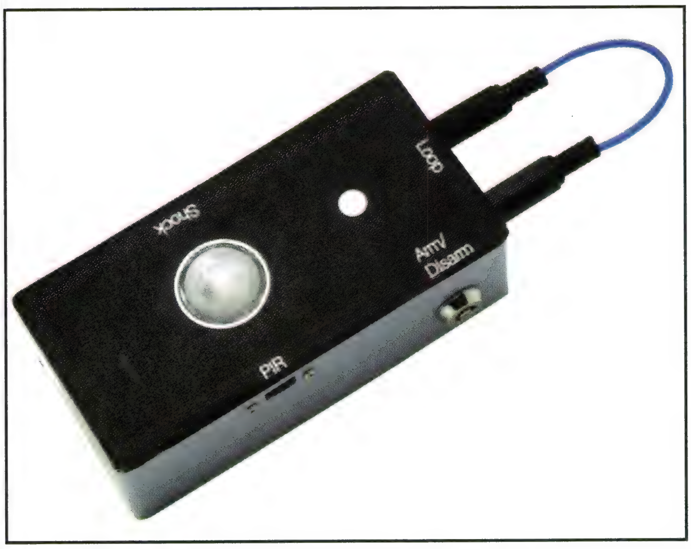
Figure 4: End point analysis: A picture of risk based on specific characteristics of input processes.

Summary

The dot.com community is only becoming aware of its potential to understand and reduce lifestyle risk. While this is in the interests of the individual, it is not in the interests of many commercial groupings. Also, we need better systems to let us understand risk and hence minimise risk in our increasingly complex infrastructure.

Points of Contact

The food pyramid-food label connection:
`http://www.fda.gov/fdac/special/foodlabel/pyramid.html`



General Purpose PORTABLE ALARM

• •

Gavin Cheeseman describes a simple, low-cost, versatile alarm

Introduction

In this article we look at the construction of a simple portable alarm with a wide range of uses. The alarm operates from a 9V battery and features a relatively low quiescent current consumption allowing many hours of operation in the standby condition. The circuit can be used as a basic vibration or loop alarm or alternatively may be triggered using an integral PIR detector. The alarm features entry and exit delays when operating in the vibration and PIR modes to prevent triggering when arming and disarming the unit. When the alarm is triggered a built in siren sounds for a predetermined time. The unit may be used in a wide variety of applications such as indicating when luggage is tampered with or when a room is entered. A keyswitch is used for arming and disarming the alarm.

How it works

A simplified block diagram for the alarm is shown in Figure 1. The circuit is fundamentally based on a series of timers. There are three main inputs. Two of these are used by the PIR and vibration (shock) sensors and the third provides an external input that can be wired to other suitable sensors with dry contact outputs. The three main inputs drive a simple latch when triggered. The latch is effectively disabled during the period of the exit delay. If a trigger event occurs after the exit delay has elapsed, this operates the latch and starts the entry delay timer. The entry delay allows a short time to elapse before the alarm sounds, during which the alarm may be disabled using the key switch. If the alarm is not disarmed, the siren sounds until it times out. It is then necessary to reset the alarm, using the key-switch, before it can be re-triggered by this method.

A second method of triggering the alarm is via the security loop. If the loop is broken the unit is triggered instantaneously. There are no entry or exit delays. The alarm still times out after the preset period has elapsed.

Circuit description

Figure 2 shows the circuit diagram of the alarm unit. Sensors are not shown. It can be seen that the circuit is based around IC1 (40106 Hex Schmitt Inverter IC). As the name suggests, the IC has six sections and these are used to perform a range of switching functions in the circuit. The circuit is designed to operate from a 9V PP3 battery power supply and this is connected between terminals P1(+V) and P2(0V). D1 provides reverse polarity protection. Sensor connections are made to input terminals P4 (shock), P5 (PIR) and P6 (External input). TR1, R1, R2, D2 and C1 form part of the shock sensor circuit and help to ensure excessive voltage spikes from the piezo transducer do not appear at the input of IC1a. This is important as excessive voltage levels can easily damage the IC. The main input lines are effectively 'OR'ed via diodes D3 - D5. Resistor R3 provides a 0V reference for IC1 pin 1 when the alarm is not triggered. IC1a, IC1b and D6 are connected to form a simple latch. When the alarm is armed but has not been triggered, the output at IC1 pin 4 sits in a logic low condition. If a trigger condition (logic high) occurs at the input of IC1a, IC1 pin 4 latches at logic high until the alarm is reset. Transistor TR2, together with R5, R6 and C2 ensures that it is not possible to trigger the latch for a short period after arming the alarm (exit delay). When IC1 pin 4 switches high, capacitor C3 starts to charge via R7 (entry delay). When the voltage at IC1 pin 5 reaches the appropriate switching threshold, IC1 pin 6 switches low and IC1 pin 8 switches high. This triggers a monostable comprising IC1e, IC1f and associated components which in turn switches on TR4 applying power to the siren. The siren continues to sound until the monostable times out. The circuit is reset when the circuit is disarmed once any remaining charge in the capacitors has dissipated.

The security loop connects to the circuit on terminals P11 and P12. When the wire loop is connected, the base and emitter of TR3 are shorted and TR3 is turned off. If the loop is broken the short is removed and current flows into the base of TR3 via resistor R8. TR3 switches on, pulling IC1 pin 11 high via diode D9; this triggers the alarm. Because the loop alarm circuit is applied directly to the input of IC1e, there is no entry or exit delay and triggering using this method is instantaneous.

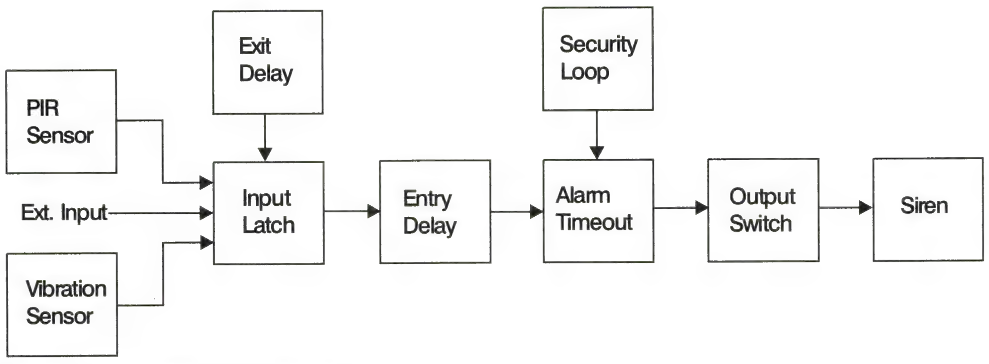
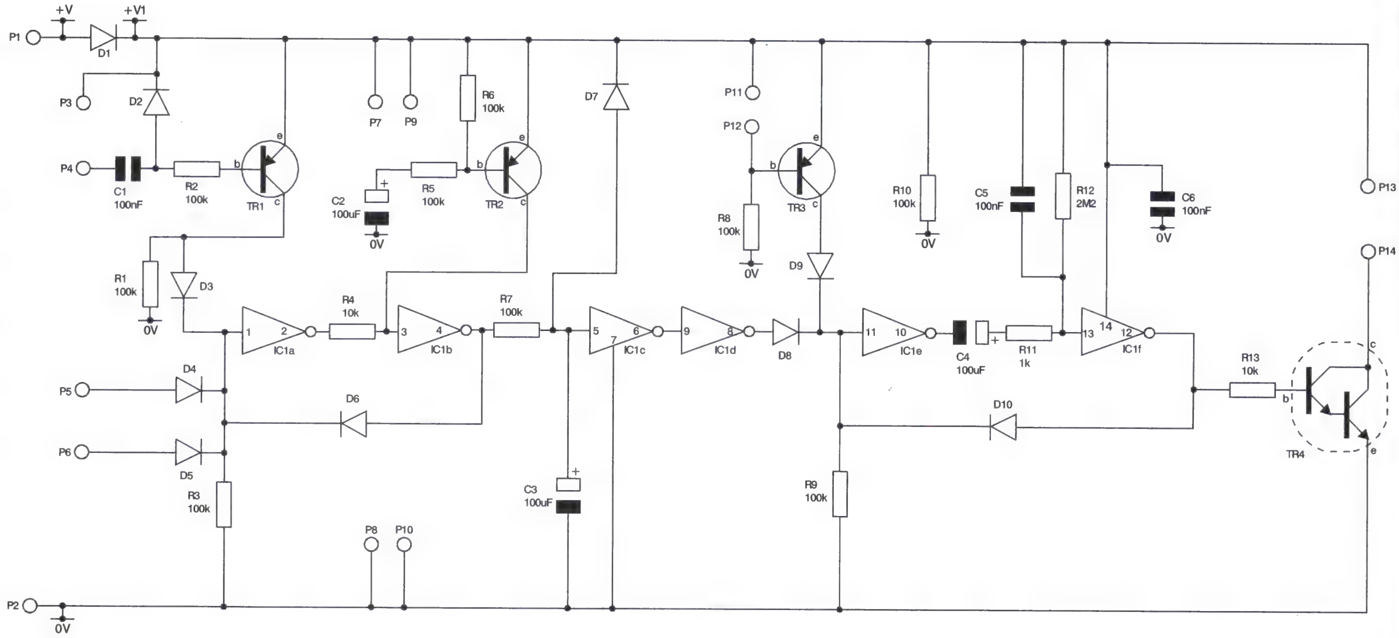


Figure 1. Simplified block diagram

Figure 2. Circuit diagram



Constructing the alarm

The alarm may be constructed using any suitable medium. Matrix board is fine. The circuit is not particularly layout critical but as with most circuits it is sensible to keep the length of the wiring as short as possible. Consider the size of the box in which the circuit board is to be mounted and try to layout the components so as to maintain efficient use of the space available. Remember that the box also has to house a number of off board components (battery, PIR module, sounder etc.) in addition to the circuit board.

Semiconductor pinout information is shown in Figure 3. The negative lead of an electrolytic capacitor is usually the shortest of the two leads. IC1 is a CMOS device and the use of a DIL socket is recommended so as to avoid the possibility of damage during soldering.

Off board wiring

Figure 4 shows the wiring diagram for the alarm unit. It is best to decide how and where you wish to mount the off-board components in the case before completing the necessary wiring. Siren wiring is coloured red (+) and black (-). The lead designations for the PIR module are marked on the module PCB. The battery clip lead is colour-coded red and black. The red lead connects to terminal P1 of the alarm circuit. The black lead connects to terminal P2. Do not connect the battery at this stage. Connections for the security loop are made to the centre (tip) connection of each jack socket. The jack plugs are wired to the loop accordingly.

Testing

It is probably best to initially test the circuit before it is finally installed in the case. Before testing, check over the alarm circuit board and external wiring errors.

Set all switches to the 'off' position and connect a suitable alkaline PP3 battery to the battery clip (rechargeable batteries are not recommended). It is useful to connect a multimeter in series with the

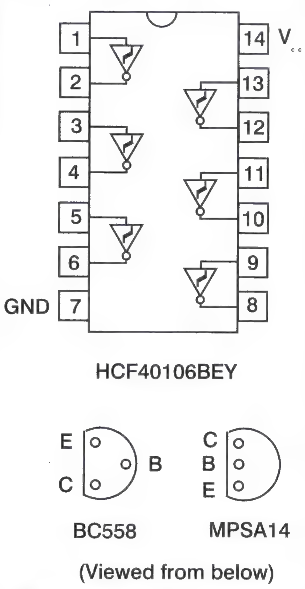
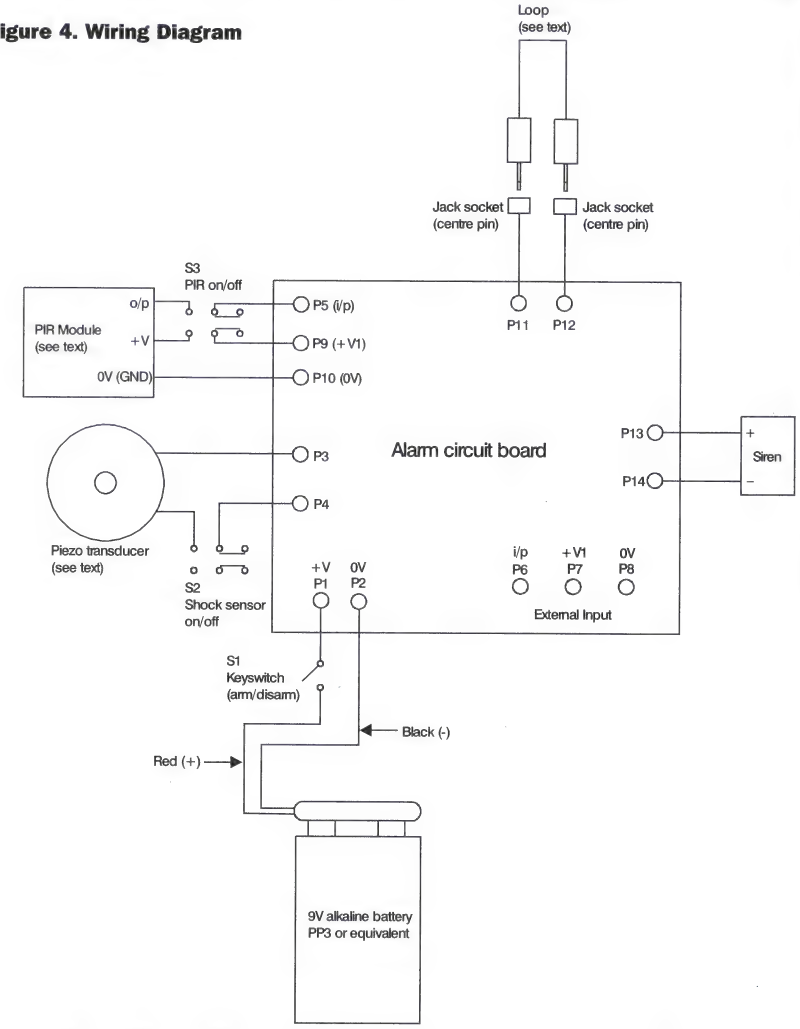


Figure 3. Semiconductor pinout information

Figure 4. Wiring Diagram



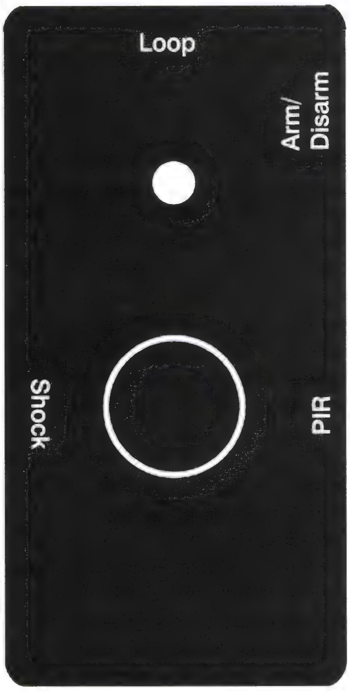


Figure 5. Example label
Picture shown at 70% of actual size

V supply when the circuit is nitially powered up as this llows the supply current to be monitored. Ensure that the ecurity loop is connected at this stage. Set S1 to the 'armed' (on) position. The alarm should remain silent. The supply current should be considerably ess than 1mA and should never exceed a few tens of mA, even when the alarm is sounding. Disconnect the security loop. This should trigger the alarm. The alarm should sound for a few minutes and then time out. Set S1 to the 'disarmed' (off) position to reset the circuit (you do not need to wait for the alarm to time out to do this). Allow a few seconds to elapse to give capacitors in the circuit time to discharge before continuing.

Set S3 to the on position. Arm the alarm and wait a few seconds for the exit delay to elapse ensuring there is no movement within the coverage area of the PIR sensor (the area viewed by the PIR lens). The alarm should remain silent. Wait around 1 minute and then move your hand in front of the PIR sensor lens. There should be a short delay of a few seconds (entry delay) after which the alarm should sound. Return S1 to the off position.

Set slide-switch S2 to the 'on' position. Arm the alarm and wait around half a minute to ensure that the exit delay is complete. Sharply tap the shock sensor (piezo transducer) a few times. There should be a few seconds delay and the alarm should sound. If everything is working correctly the circuit board may be installed into the case.

Installation

The alarm may be installed in any suitable plastic housing. An example is stock code YU53H. A typical label suitable for use with this case is shown in Figure 5. The keyswitch has two flat edges to help prevent rotation in the mounting hole. A large hole is required to allow the PIR lens to protrude. A small hole should also be drilled in the alarm case to correspond with the hole in the siren housing before the siren is mounted in position. This hole makes a considerable difference to the final volume of the siren. The circuit board may be mounted on pillars as shown in Figure 6. Depending where the jack sockets are mounted it may be necessary to remove some of the PCB guides from the inside of the case in order to allow the thread to protrude sufficiently.

Positioning of the off-board components is not particularly critical. The piezo transducer, PIR and siren need to be permanently attached to the case. Mounting holes are provided in the sensors and siren so the components can be bolted into position. Particular care is required with the PIR module. An alternative and perhaps simpler approach is to glue the sensors and siren into the case using an appropriate adhesive. The piezo transducer should be mounted facing and in physical contact with the side of the case. To save space, the PIR unit and slide switches may be mounted under the circuit board as long as the circuit board mounting pillars are long enough to allow room. Make sure that the battery is positioned such that it will not damage other parts of the circuit due to movement in normal use. Depending on the layout, it may be useful to fix the battery in position using small self-adhesive pads.

Applications

The alarm is useful for a whole host of different applications. As the circuit is based around simple concepts it cannot be expected to give the same performance as a fully featured microprocessor based alarm. However, ease of use and portability allow the unit to be set up very quickly with a minimum of fuss. Where and how the alarm is used is ultimately up to the user. The following examples give an idea of the versatility of this little alarm.

Loop Alarm

The loop alarm feature uses a loop of wire that triggers the alarm without an entry delay when the loop is broken. The wire loop is connected using jack plugs. In use the loop may be passed through an appropriate part of the equipment to be covered by the alarm or for example through handles on a cabinet door. The system should be arranged such that it is necessary to break the loop to gain access to the protected item. Breaking the loop without disarming the alarm should result in the siren sounding. Figure 7 shows a typical example of how the loop alarm may be set up. The loop may pass through a number of items. The unit could also be used as a simple bicycle alarm by placing the loop around the frame and wheel spokes. If required a number of different sized loops may be constructed to cover a range of different applications. The loop alarm may be placed in a bag and the loop fastened to the owners belt etc. If the bag is snatched the loop is broken and the alarm sounds.

It is possible for a well prepared thief to bypass the loop so this mode of operation is only recommended in applications where the user is close-by. If necessary tampering can be made more difficult by using heavily insulated wire and gluing the jack plug cover in place. Alternatively the loop may be terminated inside the case so that the case must be opened to gain access to the terminals. An additional tamper switch may be fitted as described later.

Panic Alarm

The loop alarm may also be used to deliberately trigger the unit if the user wishes to attract attention. Remember that the feature only operates when the key switch is set to the 'arm' position. To stop the alarm sounding before the timeout has elapsed it is necessary to set the key switch to 'disarm'.

Vibration Alarm (shock sensor)

In this mode the circuit is triggered when the vibration sensor detects an appropriate degree of vibration. Very small levels of vibration below the trigger threshold will not normally trigger the alarm. The alarm may be placed in baggage or on items of equipment that are not expected to be moved. However, it should be noted that the alarm must be subjected to significant mechanical shock before the shock sensor will activate the unit. Both entry and exit delays are active in this mode. The exit delay allows time for the vibration sensor to settle after the alarm is armed and the entry delay helps to prevent the alarm from sounding when you pick it up to disarm it.

PIR Alarm

The PIR alarm may be used to indicate when a person enters the area covered by the sensor. The unit may be used as a simple portable intruder alarm without any need for external wiring. When first switched on the sensor takes a short time to settle before it becomes active. This is normal for PIR sensors of this type. As with the vibration sensor both exit and

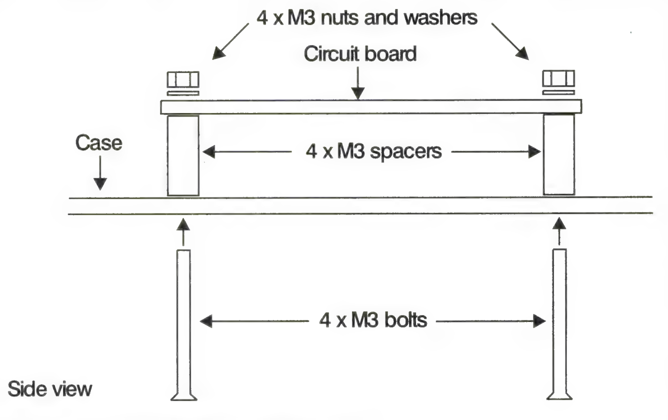


Figure 6. Mounting the circuit board

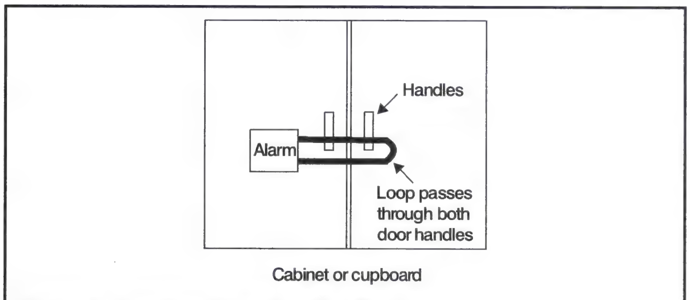


Figure 7. Loop alarm application idea

entry delays apply in the PIR mode. Make sure that the PIR covers the area you wish to guard with the alarm. If unsure, carry out a test run to check that a person entering the covered area triggers the alarm.

One point to bear in mind is that PIR sensors are designed to detect changes in the ambient infrared environment such as those produced by body heat. Unfortunately, body heat is not the only thing that can trigger a PIR detector. Other sources of rapid temperature variation are also likely to trigger the alarm and this is an important factor to consider when siting the unit. Try to avoid areas immediately under air conditioning vents or close to cooking or heating appliances. The alarm will also respond to the body heat of pets and other animals. The coverage angle of the sensor is relatively wide although this can be effectively reduced by obscuring one side of the sensor lens or by appropriate positioning close to a wall. False triggering may also be a possible problem when the alarm is used in a shed or other outbuilding where there are rapid temperature fluctuations. In this type of situation it may be preferable to use an alternative method of triggering the alarm via the external input terminals.

External Input

The external input terminals allow various types of externally wired sensor to be used with the alarm. Although the alarm is not intended for use with an extensive network of sensors, there may be some occasions where the use of an external sensor is appropriate. For example where the PIR may be prone to false triggering. The system is designed for use with sensors that have normally open (N.O.) dry contacts. Figure 8 shows how external sensors may be connected to the alarm. With a small modification normally closed (N.C.) sensors may also be used. Figure 9 shows one way of doing this. The modification results in a small increase in the quiescent current consumption of the circuit but this is not normally significant from a practical point of view. In common with the PIR and vibration modes, the external input has both an entry and an exit delay. Wiring to external sensors should be kept as short as possible. It may be necessary to connect a small decoupling capacitor across the external input terminals in some instances, to avoid false triggering by RF fields. The required value depends on a number of factors but a typical figure would be in the region of a few nF. False triggering by very strong RF fields can often be a problem and is not always simple to cure. If the signal is being picked up by external wiring the inclusion of a small choke or ferrite ring close to the alarm input can sometimes provide an effective solution.

Whichever mode is being used, the condition of the battery should be checked regularly. A simple way to do this is to arm the alarm and open the security loop. If the battery condition is poor the volume of the siren will be reduced.

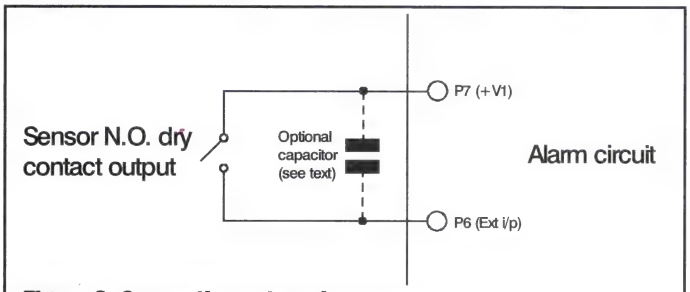


Figure 8. Connecting external sensors

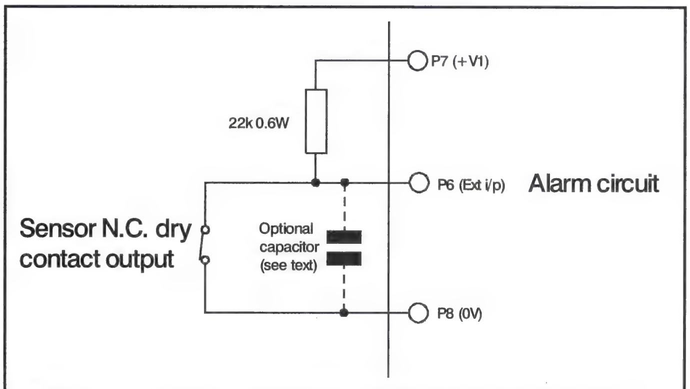


Figure 9. A method of connecting normally closed external sensors.

Modifications

For those readers who enjoy experimenting with circuit design, there are several modifications that can be carried out to enhance the performance of the alarm. The exit and entry delays can be made user adjustable. In order to achieve this it is simply necessary to fit variable resistors in series with the existing timing resistors. For example to make the entry delay adjustable, connect a variable resistor in series with R7. Specific component values depend on the range of adjustment required. A value of 1M should provide a good starting point.

The standard alarm does not provide tamper protection for the case. A small microswitch may be fitted inside the case and connected in series with the security loop. The switch should be positioned so that it is closed when the case cover is in position. When the cover is removed the switch opens and the alarm is triggered. The security loop may also be extended to cover other external sensors.

Finally...

Although very simple in concept, this little alarm unit can be very effective. It also provides a introduction to the concepts behind larger and more complex security systems. Of course, a simple unit of this type can only provide a limited degree of security and cannot be guaranteed to afford protection in all circumstances. Nevertheless the alarm is fun to build and has a host of different uses.

PROJECT PARTS LIST

RESISTORS			
R1-3, 5-10	100k	9	M100K
R4, 13	10k	2	M10K
R11	1k	1	M1K
R12	2M2	1	M2M2
CAPACITORS			
C1, 5, 6	Disc 0.1µF 50V	3	BX03D
C2-4	GenElect 100µF 16V	3	AT40T
SEMICONDUCTORS			
D1	1N4001	1	QL73Q
D2-10	1N4148	9	QL80B
TR1-3	BC558	3	QQ17T
TR4	MPSA14	1	QH60Q
IC1	HCF40106BEY	1	QW64U
MISCELLANEOUS			
	DIL Socket 14-Pin	1	BL18U
P1-14	Pin 2145	14 pins	FL24B
	PP3 Clip	1	HF28F
	PIR Sensor Module	1	YD85G
S1	Min Round Key Sw	1	CJ92A
S2, 3	Sub-Min Slide	2	FH35Q
	Jack Socket 3.5	2	HF82D
	HP Buzzer	1	FK84F
	ABX Box PX2	1	YU53H
	Plug Plas 3.5	2	HF80B
Shock Sensor	Min Piezo Sounder	1	FM59P

SCSI, IDE or USB? External or internal? Price? Speed? CD-RW? Mac or PC? Choose the drive that's best suited to your individual needs.

Mastering AUDIO

The CD-R(W) drive is undoubtedly one of the most useful peripherals available, not least because they allow you to make your own audio CDs! Martin Pipe examines how you can get the best results and also discuss MPEG audio, along with making MP3 CD-ROMs optimised for the stand-alone player.

Hardware Requirements

Since we first delved into the wonderful world of CD audio mastering, back in 1997, a lot has happened. Most importantly, the choice of CD burners has widened considerably. Intense competition has brought prices down to everyday-consumer levels - some mail-order and computer-fair vendors are selling basic two-speed models for less than £100. Today's IDE interfaces, and the peripherals attached to them, are of a good enough performance for reliable CD mastering. The 'buffer-underrun' errors and ruined disks that were once a frequent occurrence are now a thing of the past.

That's not to say SCSI burners - which tend to be more expensive - don't have their place. If your PC only has one drive bay, a SCSI drive, mounted in an external enclosure, will allow you to make copies (sorry, ahem, backups) of discs without having to copy all of the files (or songs) to your hard disk first. External SCSI drives are also a natural choice for owners of older Macs. Practically all modern burners - regardless of interface - support digital audio extraction (DAE), or the ability to 'rip' one or more audio tracks from an audio CD and copy them to your hard disk as WAV files. A moot point if your current CD-ROM drive isn't DAE-ready. DAE is, of course, essential if you want to make 'compilation' CDs of your favourite music, culled from a selection of albums. All current CD mastering software supports DAE, although stand-alone programs capable of doing the job - such as Audiograbber and AudioCatalyst - are available via the Internet. Some of these even have MP3 converters built in, making ripping and conversion of a CD pretty much a one-click operation.

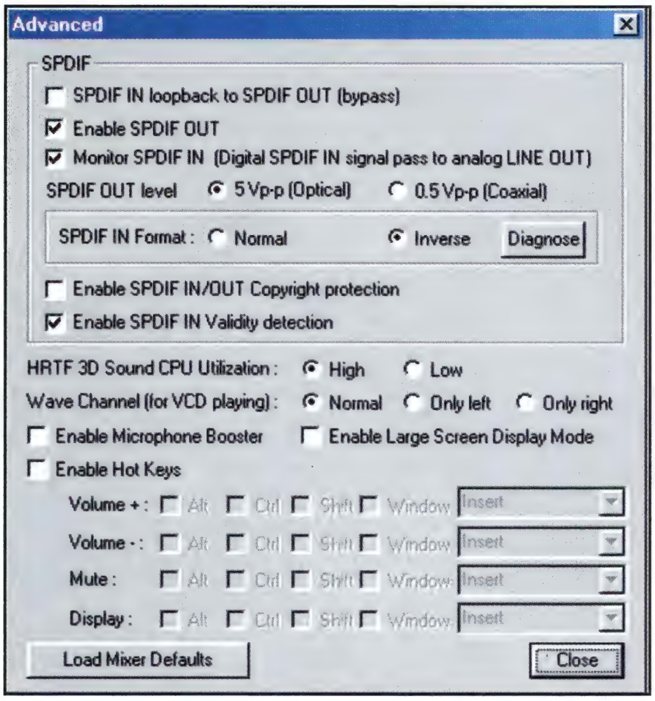
Over the last couple of years, a new PC interface - USB - has risen in popularity. This high-speed serial interface is fast enough to support reliable multi-speed CD recording. In addition to scanners, printers, webcams, external hard drives and mice we now have USB-interfaced CD burners. These offer the SCSI-like flexibility of external enclosures, leading to less power consumption and greater long-term reliability (after all, the drive is only connected and powered up when it's needed). Unlike SCSI, though, you don't need to run to the expense - and the extra PCI peripheral slot - of a host adaptor. Instead, all recent PC motherboards include the relevant USB port, which is brought out to the rear panel. USB is also exceptionally Mac-friendly. The popular iMac, launched some time after our original series of articles, only caters for this form of external peripheral interfacing. iMac owners thus have no choice other than a USB-interfaced burner if they want to make their CDs.

So what else has happened to make the lives of budding CD producers cheaper and easier? Most obviously, CD-R prices have fallen considerably. Back in 1997, a 74 minute 'branded' blank would have set you back around £4 - today, the same disc only costs £1 or so. And of course, much has happened to the computer hardware since then. Hard disks are now much more capacious, and it's now possible to buy a 20GB drive for less than £150. WAV editing programs tend to eat up a lot of space with temporary files - the size of today's drives means that you're much less likely to see 'disk full' error messages.

The upshot? CD audio mastering is now very affordable, and so why not give it a try? The same drives, media and mastering software does a lot more into the bargain - you can backup your hard disk (quite relevant in these days of well-publicised e-mail viruses and widespread Internet use) and archive files. In the remainder of this article, though, we'll be concentrating on audio applications - of which there are many.

Soundcards

Your soundcard - which must be a 16-bit type - is the ultimate arbiter of sonic quality. After all, it's the device that's used to source audio from an external source. Cheap (£20 or less) soundcards generally have rather poor analogue stages. Although the effects here won't be noticeable through a typical PC's multimedia speakers, they will be when you master a CD from an analogue source and play it on a reasonable hi-fi system. Obvious shortcomings include a lack of fine detail, top end 'sparkle' and bass. Some cheap cards can be heard to distort quite badly, too! There is, however, one inexpensive card that's well worth considering - particularly if you have a MiniDisc or DAT recorder with SP/DIF output. The £10 Audio Excel AV511 - based around CMedia's 'single chip' CM8738 solution - does have a fairly lacklustre analogue performance, but more than makes up for this with SP/DIF input and



SPDIF
☐ SPDIF IN loopback to SPDIF OUT (bypass)
☑ Enable SPDIF OUT
☑ Monitor SPDIF IN (Digital SPDIF IN signal pass to analog LINE OUT)
SPDIF OUT level ● 5 Vp-p (Optical) ○ 0.5 Vp-p (Coaxial)
SPDIF IN Format : ○ Normal ● Inverse
☐ Enable SPDIF IN/OUT Copyright protection
☑ Enable SPDIF IN Validity detection
HRTF 3D Sound CPU Utilization : ● High ○ Low
Wave Channel (for VCD playing) : ● Normal ○ Only left ○ Only right
☐ Enable Microphone Booster ☐ Enable Large Screen Display Mode
☐ Enable Hot Keys
Volume + : ☐ Alt ☐ Ctrl ☐ Shift ☐ Window Insert
Volume - : ☐ Alt ☐ Ctrl ☐ Shift ☐ Window Insert
Mute : ☐ Alt ☐ Ctrl ☐ Shift ☐ Window Insert
Display : ☐ Alt ☐ Ctrl ☐ Shift ☐ Window Insert

output. You can thus make digital transfers from SP/DIF-connected sources - with no loss of quality whatsoever!, as digital audio effectively passes directly to the PCI bus. It has to be enabled first, using the 'advanced mixer' controls

Some MiniDisc and DAT decks, notably Sony models, will act as analogue-to-digital converters if 'record' is selected with no media present - under these circumstances, the front-panel display will indicate 'AD-DA'. In the same mode, the machine is also capable of acting as a high-quality DAC if the AV511's S/PDIF output is hooked up to one of the digital outputs (switch the input selector to the input in question, and the display will show '-DA'. Couple one of these digital recorders with an AV511, and you'll end up with a sound quality that's better than what's offered by any consumer-level soundcard. Keeping the sensitive analogue electronics away from the PC's noisy innards is a distinct advantage, as is the 'audiophile' quality circuitry specified by most hi-fi grade digital recorders. In order to work properly with external digital sources, the AV511 requires some external interfacing, which is described elsewhere in this issue - the AV511 formed the basis of our audio PC. The card is supplied with a mixer software application. You'll need to enable the SP/DIF input for digital recordings - we also recommend disabling the unwanted inputs (mike, line, CD audio and so on) to reduce the possibility of unwanted noise. Although digital audio from the S/PDIF input is passed 'as-is' to the bus, so too is the converted analogue output. Note that a previous Audio Excel card, the AV511, is capable of similar results. This card's CMedia CM8338 chipset is very similar to the CM8738, but doesn't support 48kHz sampling rates (whether from analogue sources, or from S/PDIF ones like DAT). What's more, the CM8338 doesn't have the modem interface of the CM8738 - not that it's relevant here!

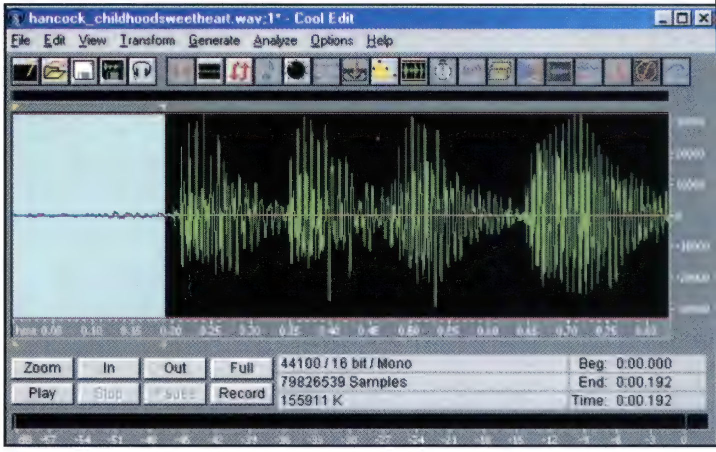
If you don't yet have a digital source, but want to author from analogue sources, you could always consider Creative Lab's Soundblaster Live! If our experience is anything to go by, this card is capable of making very good captures from analogue sources. In its most expensive 'Platinum' guise, the Live! is supplied with a connector panel - known as the LiveDrive - that sits in a spare 5.25in. drive bay. The LiveDrive provides accessible connections for analogue stereo phono in, microphone jack, standard 5-pin DIN MIDI in/out, headphones and optical/coaxial S/PDIF input/output. Unfortunately, you'll still need to root around the back of your PC for a line-level analogue output. Note that a similar connector bay can be constructed for the AV511, and indeed other soundcards, from an old PC front-panel blanking plate. The Live Platinum is supplied with an excellent software bundle that includes games, an audio effects manager, 'virtual turntables' mixing software and Steinberg's Cubase VST music production package. Indeed, the Live is an excellent choice for budding musicians, not least because it can be turned into an effective sampler merely by substiting the supplied wavetable sounds with your own. There are some criticisms, though. First of all, the digital output has a fixed sample rate of 48kHz, regardless of what you're listening too.

Although MiniDisc recorders have in-built sample rate converters, I can't imagine that upconverting thé sample rate from 44.1 to 48kHz at the Soundblaster end, followed by a down-conversion to 44.1kHz at the Minidisc end, is going to have a particularly positive effect on sound quality. Still, this is irrelevant as far as CD audio mastering is concerned. - the issues only apply if, for example, you want to transfer MP3s or WAV files onto Minidisc. The Live! doesn't, however, integrate particularly well with Iomega's superb RecordIt program. That's not to say it doesn't work, but you need to be careful or you'll record only silence. Our final option as far as soundcards is concerned extends to the original Soundblaster 16 (SB16). Turn to my article MP3 Update in this issue, and you'll discover how to make your hardware sound much better by replacing its analogue input stage. The same comments apply to the AWE32 and AWE64, both of which are based around the same AK4501/CT1703 codec IC used by the SB16. If you don't have one of these cards, it may be worth finding out more about its chipset. Look around on the 'Net for datasheets, and yo might be able to find a way of modifying your card for better sound quality.

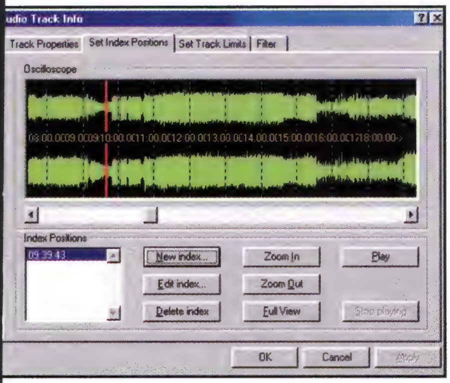
Soundcards are happy with line-level sources, such as cassette decks, tuners, re to-reel recorders and hi-fi VCRs (the latter a formidable but little-exploited option, wi up to 10 hours of audio recording on a E300). Just connect them directly to the soundcard using a dual phono-to-3.5mm stereo jack cable. The 'Deluxe' version of Adaptec's Easy CD Creator is supplied wit such a cable. As an alternative, you could make your own - or purchase a ready-mad 1.2m cable (KQ12N). One of the most useful applications of a CD audio recordin system, however, is getting those old vinyl records onto user-friendlier CDs. A soundcard cannot be fed directly with the low-level outputs of a magnetic cartridge. They need to be amplified, and corrected according to the RIAA equalisation curve. The required circuitry is, however, found i hi-fi amplifiers and DJ-type mixers - in both cases, simply connect the 'tape out' phono sockets to the soundcard's line input usin the cable just described, and select the equipment's 'phono' input. If you don't have a mixer or amp with a phono input, you could always build your own preamplifier.

Recording and editing

OK, so you've wired up your equipment. How do you make the best possible recordings? Well, you'll need an audio editing program. One of the most popular i Syntrillium's Cool '96, a PC Windows 9x shareware program which can be downloaded from a variety of sites. Unfortunately, you won't find it on Syntrillium's web site, because they've sinc replaced it with an updated (but time-limited) program known as Cool Edit 2000. The original Cool '96 - and its replacement allow you to record, modify and save audio captures in a number of audio file formats - including the 16-bit stereo 44.1kHz one needed for Red Book-standard audio CDs. The program also features sample rate conversion, so that you can transfer 48kHz DATs onto CD. Cool '96 - and its time-limited successor Cool Edit 2000 - are well-served with plug-ins for MP2/MP3 conversion, digital noise reduction and so



44100 / 16 bit / Mono
79826539 Samples
155911 K
Beg: 0:00.000
End: 0:00.192
Time: 0:00.192



n. We'll concentrate on using Cool '96 for he purposes of this article, but other rograms of this type are equipped with imilar features. If you have more than one oundcard in your system - as with the udio PC featured elsewhere in these pages you'll need to select the soundcard before ou can begin. You'll find the menu you eed, 'select wave device', under the options' menu. Very flexible and useful, in other words. Another handy feature of Cool 96 is its pair of peak-reading input meters, which can be used to calibrate input levels before capture begins. These can be adjusted with conventional rotary controls (if you're using a MiniDisc/DAT deck as an ADC, or the audio PC featured elsewhere in this magazine), your source equipment's playback level control or the 'line input' fader of the Windows 'virtual' mixer panel (which can be accessed by clicking on the speaker symbol that should be visible on the taskbar). Peaks should register at 0dB - the highest point of the meter - if the best dynamic range is to be achieved. 0dB correlates to a sample in which all 16 bits are fired up as ones; put another way, you can't go any higher! When the input signal level meets or exceeds the resolution of the ADC, Cool Edit flags up a red 'clipping' indicator for the relevant channel.

Which brings us neatly to a handy little gadget that you can knock up fairly quickly. The swtchbox depicted in Figure 1 is particularly valid for those of you who want to transfer analogue tape or cassette recordings onto CD-R. The device, which sits between the cassette/tape deck and the soundcard's line inputs, would normally be used in the monitoring phase prior to capture. The rotary switch will determine whether the left, right, mono (left and right) or normal stereo audio signals are passed to the soundcard. It's thus easy to fully check programme quality prior to capture. The mono position is particularly interesting, since it allows you to check the replay azimuth alignment. If the head is out of alignment relative to the tape, then the treble will sound rather wishy-washy. This is because azimuth misalignment introduces phase distortion. The effects of azimuth adjustment are particularly obvious when you're playing a mono recording on a stereo machine. A slight physical delay between the left and right playback heads will, if the machine's stereo outputs are combined into one by our switch, cause the shorter-wavelength higher-frequency signals to cancel each other out. The azimuth setting on your replay machine - normally a grubscrew - can be adjusted until optimal treble output is attained. When the best compromise has been reached, the switch can be changed to its normal 'stereo' position. When transferring mono material, you might find that one of the stereo channels might deliver the best results - simply select the appropriate channel prior to capture.

After calibrating your level controls and setting up your replay equipment, you can start capturing audio to your hard disk - Cool '96 is equipped with tape-recorder type controls for this purpose. The peak level meters are still displayed for monitoring purposes, although they're not refreshed as often because processing power is being diverted elsewhere! 'Record' invokes capture, while 'stop' does the opposite. When 'stop' is pressed, the audio captured until that point is displayed in a pictorial form akin to that of an oscilloscope screen. Keep captures as short as possible, in order to reduce processing and saving times. This, of course, isn't always possible - especially if you're capturing an entire hour-long concert off the radio in one go. Now it's time to edit, but before you do so save your work in case you make any mistakes! Cool '96 enables you to 'zoom in' on the waveform, and - in conjunction with regular playback - accurately identify parts of the capture (such as announcements) that you don't want on your CD! You can highlight the areas in question with your mouse, and delete them (select 'delete selection' from the 'edit' menu).

If you want to produce a concert CD from a radio broadcast, but want to split the tracks up instead of producing the entire disc as one track, then Cool '96 can help you. Identify, through playback and waveform monitoring, the gaps (normally applause) between the tracks. Cut the track that precedes it, and paste it into a new instance of Cool '96. You can then save the track separately. Repeat until all of the tracks have been processed in this way. When making the final CD, remember to select the 'disc-at-once' option - which eliminates the two-second gap between tracks. Note that at least one recent CD authoring package - Ahead's powerful Nero - has a less cumbersome track-split function. The 'Set Index Positions' option within Nero's 'Audio Track Info' menu gives you the opportunity to define 'index' points that determine when one track ends and the next begins. Once again, you must remember to select the 'disc-at-once' burn option.

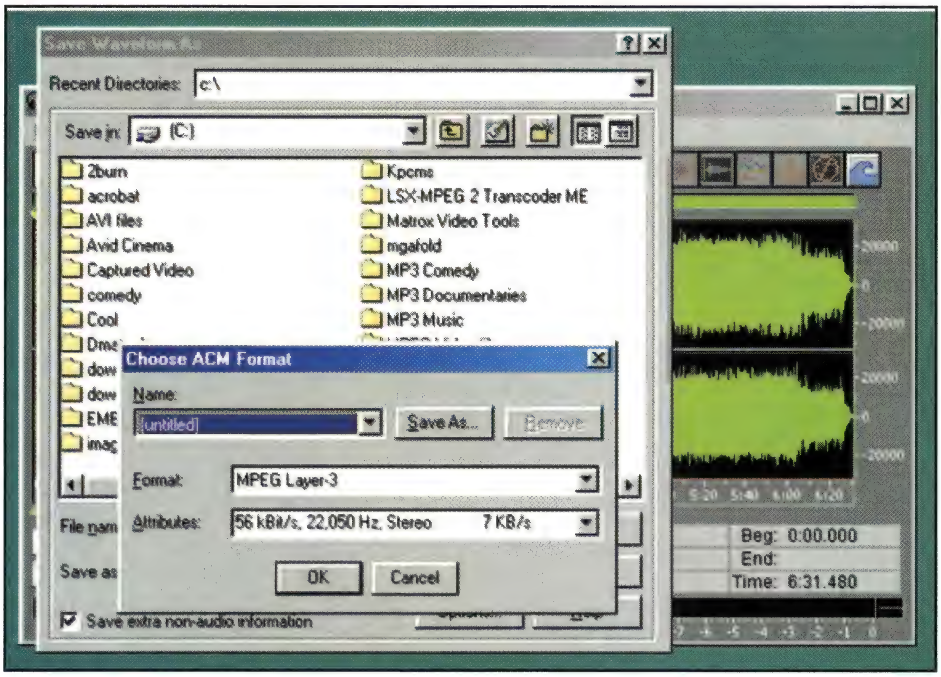
Sometimes, though, there might not be enough signal to make the most of the ADC's resolution. An obvious example - at least for the time being - occurs when you're trying to make a digital recording, via S/PDIF, from a DAB-type tuner. I have found that the broadcasts of BBC and commercial stations alike seem to peak at around -8dB. In other words, those DAB broadcasters don't appear to be making the most of the dynamic range afforded by DAB's 16-bit resolution! If you're making a recording of, say, a live broadcast and decide to put it onto a CD-R (for your own enjoyment, naturally), then you'll find that it sounds rather quiet compared to your normal audio CDs. Fortunately, Cool '96 has a very useful audio level normalising feature. You'll find it if you select the 'amplify' menu (look under 'transform/amplitude'). Simply set the 'peak level' box to 100% (i.e. 0dB) and hit 'calculate'. The software will then scan the capture, automatically working out the gain factor needed to bring the highest signal peaks up to 0dB.

Remember to normalise audio levels before splitting up a concert audio recording! If your machine is relatively low-powered and you want to avoid long waits, seek out the loudest passage and note the optimum gain setting found by the software. This figure can then be applied individually to all of the tracks. The 'normalise' feature is also very useful when bringing together tracks sourced from a selection of CDs, for the purposes of a compilation album. You'll usually find that volume levels vary widely, indicating that digital mastering hasn't always been done properly! Sometimes, though, the dynamic range has been deliberately compressed - as a 'full' view of the waveform will suggest. Nevertheless, Cool '96's 'normalise' feature does help you to make audio levels consistent across your entire CD. You'll also find highly-configurable 'fade in' and 'fade out' options in the 'amplify' menu, which are useful for live recordings and tracks that you want to shorten. I recommend the 'linear' option.

MPEG Audio

Most modern audio editing packages, such as Cool Edit 2000 and the latest incarnation of Goldwave, make some kind of provision for MP3 output - here, the WAV file is compressed into MP3 format. Sometimes, as in the case of Cool '96, a MP3 plug-in is available as share- or freeware from various sites. But what if yours doesn't? You could always process the files with a standalone conversion program, many examples of which can be found on the Internet. There's even a DOS freeware one (l3enc.exe) available from many web sites. Good

Creative Lab's high-end Soundblaster Live! Platinum soundcard. The 'Platinum' suffix means you get the convenient Live!Drive plugbay, which is clearly visible to the right of the picture.



Name: [untitled]

Format: MPEG Layer-3

Attributes: 56 kBit/s, 22,050 Hz, Stereo 7 KB/s

starting points for such programs are the MP3-specific sites (such as www.mp3.com) as well as the more-generalised shareware search engines (www.shareware.com). The programs available change on an almost-daily basis, owing to MP3's current status as a 'hot' technology. Most Windows packages, including Cool '96, have an ACM (Audio Compression Manager) export facility that allows the file to be saved using a third-party Windows codec. You may well find that some other application has already installed a MP3 codec. In Cool '96, simply select 'ACM' from the 'save as type' options. Click on 'options' - MP3, if present, will be found in a pull-down menu that's accessed by clicking on 'format'. 'Attributes', meanwhile, allows you to specify the sampling rate, bitrate (the level of compression applied) and whether the output should be in stereo or downmixed to mono.

Some more advanced programs and codecs support the more efficient joint stereo (in a similar manner to the pilot-tone analogue FM stereo system, this transmits the lower-bandwidth difference between stereo channels on second channel) and variable bit-rate - VBR - encoding (the bandwidth of the compressed file varies dynamically according to the complexity of the musical passage). VBR works very well, and it's not uncommon to end up with a smaller-than-expected file with higher-than-expected sound quality. If you're producing MP3s for the player project, stick to a sampling rate of 44.1kHz otherwise the player's S/PDIF output won't work properly - although the analogue outputs should be fine. In my experience of stereo 44.1kHz 16-bit conversions, 96Kbps is fine for most speech radio programmes - at the other end of the broadcast spectrum, 128Kbps should suffice for live concerts sourced from a digital radio source. CD material benefits from rates between 128Kbps and 192Kbps. There's an often-perceptible difference in the sound quality between MP3 compression programs. Generally speaking, the quicker the conversion the poorer the sound quality. Most MP3 compression utilities have a 'quality' slider that allows you to trade off sound quality against processing time. A badly-compressed 128Kbps or 192Kbps track can often sound worse than a well-compressed 96Kbps one!

Double the Quantity

There is, would you believe it, a way of doubling the amount of material you can fit onto a CD. No compression is involved, and the result is compatible with any CD player. There is, as you would expect, a catch! First of all, the system only applies to mono material. Secondly, it's doubtful whether it adheres to the Red Book standard - but who cares, along as it works? The idea was conceived out of the need to archive a series of mono comedy programmes, each being half an hour in length, on the minimum number of CDs. Mono CDs apply the same signal to both stereo channels, which is wasteful. Why not apply a different mono track to each channel - thus doubling the potential storage capacity? In other words, a single CD will accommodate four, rather than two, half-hour programmes. Playback will involve turning your hi-fi amplifier's balance control fully anticlockwise (left) for one track, or fully clockwise (right) for the other. The disadvantage is that the sound only comes out of one speaker! An alternative is, of course, to wire the switchbox detailed in Figure 1 between the CD player and amplifier. Some 1970s-vintage amplifiers, interestingly enough, are equipped with a 'mode' switch that does the same job. My old Pioneer SA9500 Mk2 is one such amp. The separate text describes how dual-mon WAV files can be created - these can then b burnt onto CD using any authoring packag (including the one supplied with your burner).

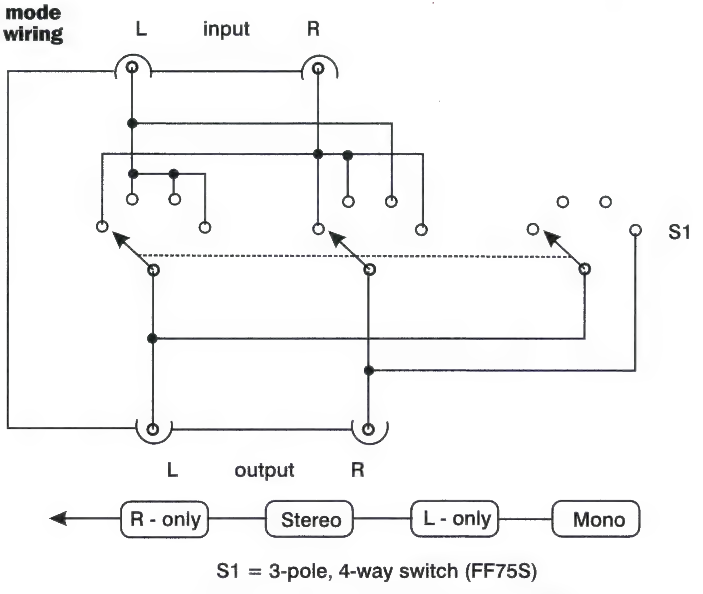
Conclusion

Mastering your own audio CDs is a fun and worthwhile experience that would have seemed impossible a few years back. Do th job properly, and you can achieve worthwhile results. Although stand-alone CD audio recorders are available, they are not as flexible and require special 'audio-only' blank discs that sell for four times the price of the more common audio variety. Today, both the computer-based and stand-alone varieties are capable of writing to rewritable (CD-RW) discs. Be careful here - owing to a lower recording-surface reflectivity, audio CD-RW discs can only be played on a limited number of recent CD players.

Copyright Warning

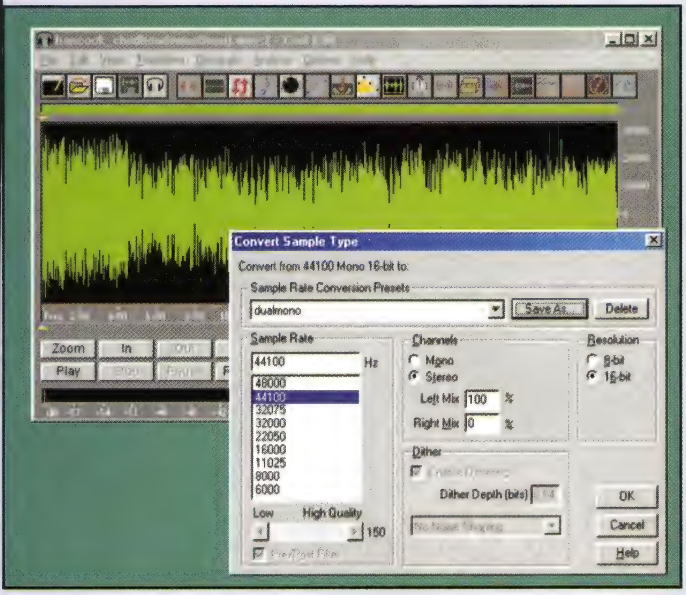
With the equipment and procedures outlined in this article, it is possible to make recordings of copyrighted works. If this is the case, such recordings must be made solely for your own use, and then only if you have the original recordings. If you do not own the copyright, or have permission to copy from the copyright owner, you may be violating copyright law and could be subject to payment of damages and other remedies. If you are in any doubt, please contact your legal advisor.

Figure 1. Stereo mode audio switchbox wiring diagram.



reating dual-mono WAV files, using Cool '96

1. Capture your mono material as a 16-bit mono WAV file. Normalise volume levels for each capture, as described in the main text.
2. Note down the lengths of each capture, listing them from shortest to longest. You will be sequentially pairing of files of similar length, starting from shortest to longest, to form 'stereo' WAV files.
3. Convert the longer of the two captures into a stereo file, by selecting 'convert sample type' from the edit window. Go to the 'channels' option, and choose 'stereo'. Enter '100%' in the 'left mix' box, and 0% in the 'right mix' box. You should see you original mono capture on top (this will be the left channel), and 'silence' at the bottom - it's into the latter (right channel) that the second clip will be pasted.



Convert from 44100 Mono 16-bit to:

Sample Rate Conversion Presets: dualmono

Sample Rate: 44100 Hz

48000
44100
32075
32000
22050
16000
11025
8000
6000

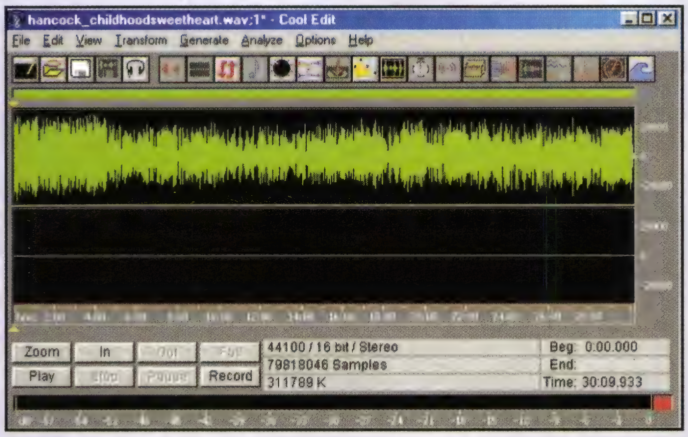
Low – High Quality: 150

Channels: ○ Mono ● Stereo

Left Mix 100 %

Right Mix 0 %

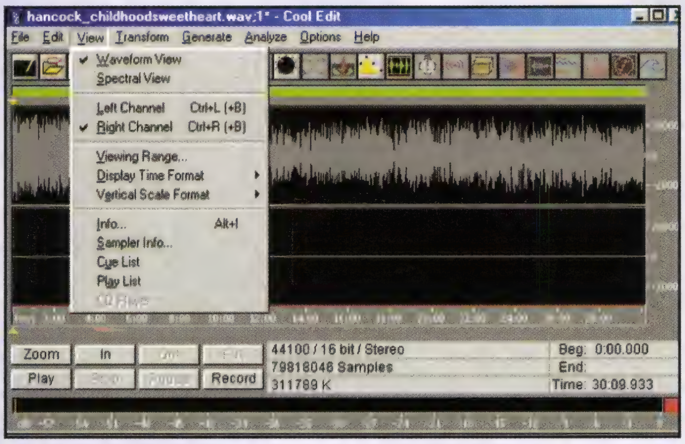
Resolution: ○ 8-bit ● 16-bit



44100 / 16 bit / Stereo
79818046 Samples
311789 K

Beg: 0:00.000
End:
Time: 30:09.933

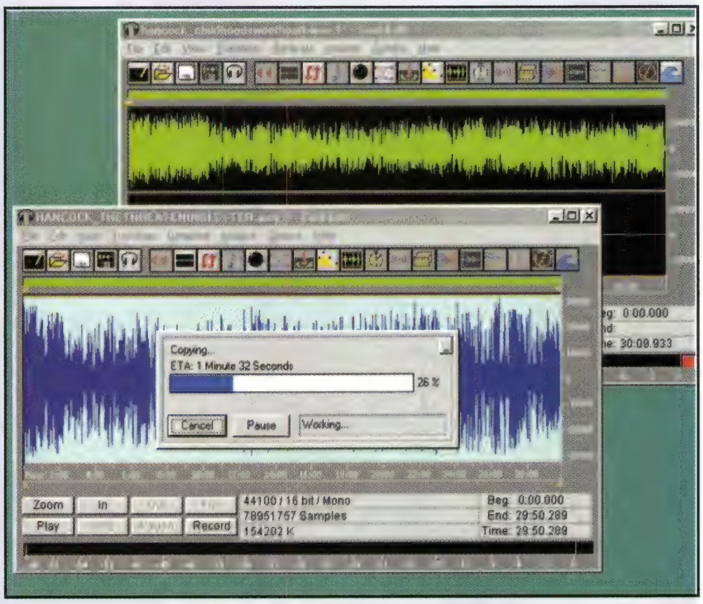
4. From the 'view' menu, select 'right channel' only.



44100 / 16 bit / Stereo
79818046 Samples
311789 K

Beg: 0:00.000
End:
Time: 30:09.933

5. Open up the second, shorter capture of the pair in another instance of Cool '96. Select 'entire wave' from the 'Edit' menu, and then copy.

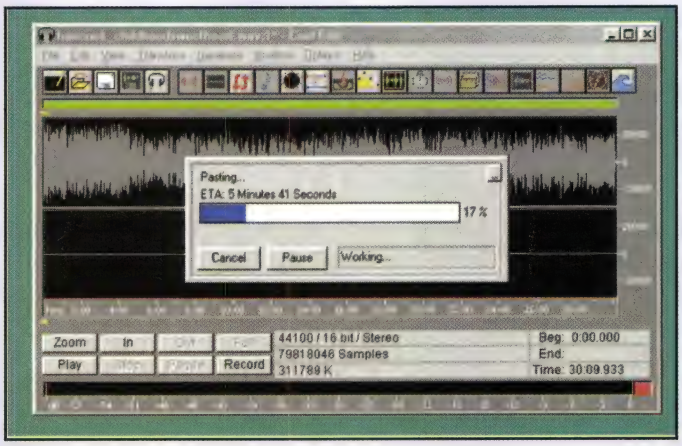


Copying...
ETA: 1 Minute 32 Seconds
26 %

44100 / 16 bit / Mono
78951757 Samples
154202 K

Beg: 0:00.000
End: 29:50.289
Time: 29:50.289

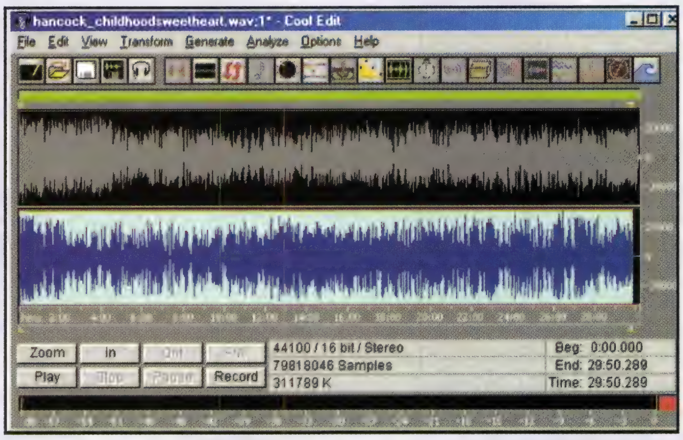
6. Go to original instance of Cool '96, and paste into right channel. You should now see two independent audio tracks on the timeline. Go to 'view' menu and re-enable the left channel. If you select play, a different track will heard from each speaker!



Pasting...
ETA: 5 Minutes 41 Seconds
17 %

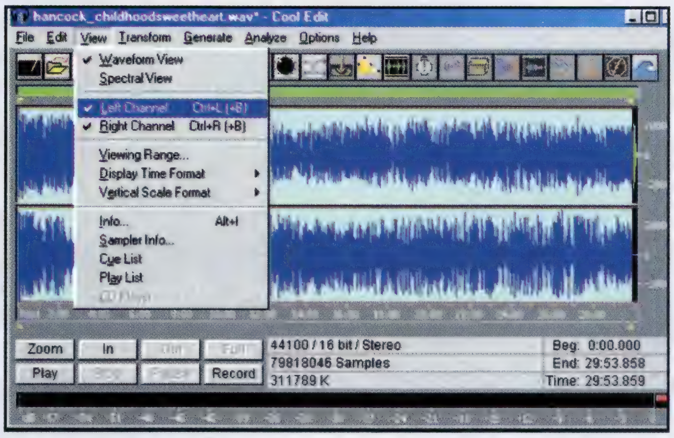
44100 / 16 bit / Stereo
79818046 Samples
311789 K

Beg: 0:00.000
End:
Time: 30:09.933

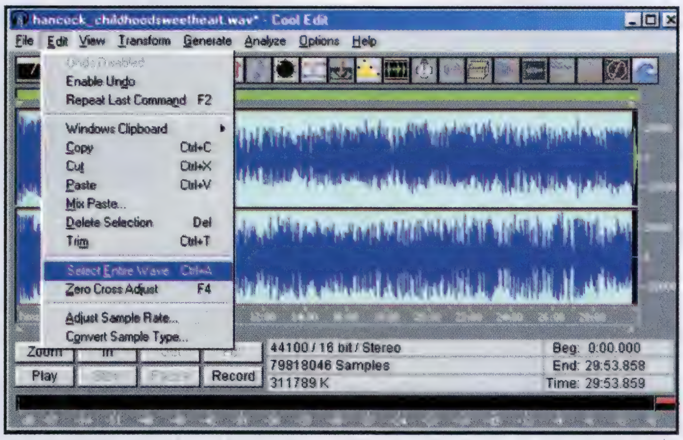


44100 / 16 bit / Stereo
79818046 Samples
311789 K

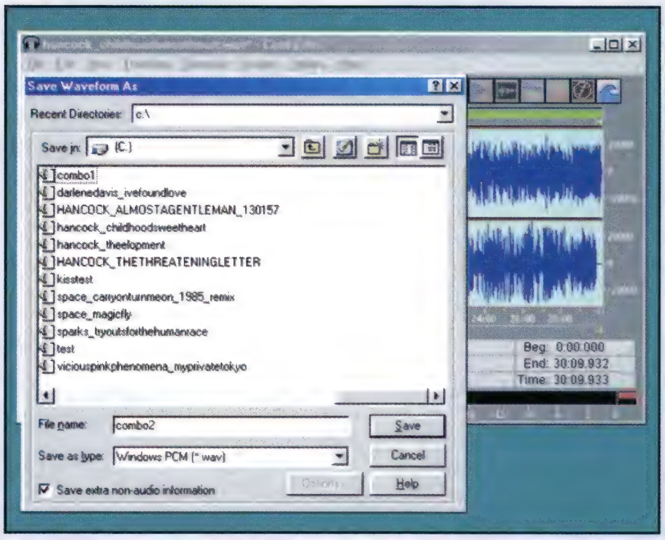
Beg: 0:00.000
End: 29:50.289
Time: 29:50.289



7. Select the entire file and save your dual- mono file under a different filename - such as comboxx.wav.



8. Repeat steps 3 to 7 with the next pair of files, until you have enough material to fill a CD (i.e. up to 74 minutes of dual-mono material). The dual-mono files can then be committed to CD-R in the normal way, using your mastering software.


Save Waveform As
Recent Directories:
Save in:
combo1
darlenedavis_ivefoundlove
HANCOCK_ALMOSTAGENTLEMAN_130157
hancock_childhoodsweetheart
hancock_theelopment
HANCOCK_THETHREATENINGLETTER
kisstest
space_canyonturnmeon_1985_remix
space_magicfly
sparks_tryoutsforthehumanrace
test
viciouspinkphenomena_myprivatetokyo
File name:
Save as type:
Save
Cancel
Options
Help
Beg: 0:00.000
End: 30:09.932
Time: 30:09.933

Recent Directories: c:\

Save in: (C:)

File name: combo2

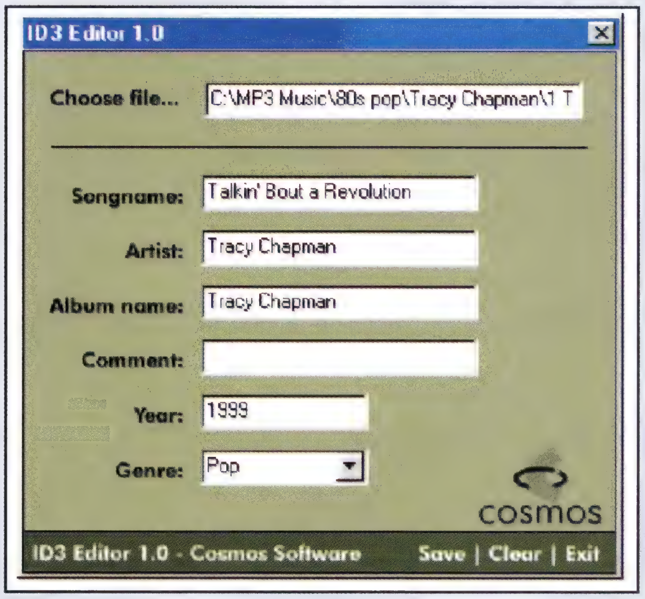
Save as type: Windows PCM (*.wav)

☑ Save extra non-audio information

Organising MP3 CD-ROMs for the DOS-based MP3 CD player

Here, the information on each song (or other audio clip) is contained within an ID3 tag, rather than the filename. DOS filenames, unlike those of Windows 9x, are restricted to 8 characters (the extension must always be .MP2, or .MP3, according to whether Layer 2 or Layer 3 MPEG compression is used).

1. Create MP3 files, and store them in an album-specific directory.
2. Edit the ID3 tags - track/artist and other text information than can be 'buried' in MP2/3 audio files - using a stand-alone third-party application (such as Cosmos' freeware ID3 Editor, available from `www.neutralzone/org/cosmos/`) or the ID3 editor within Winamp (you'll find this within the inappropriately-named 'view file info' menu).
3. Rename the files in each directory to meet the DOS 8.3 convention along the lines of albxxx01.mp3. The first characters of the filename are specific to the album, and should be followed by numbers that indicate the track number. If the album contains more than 9 tracks, tracks 1 to 9 must be numbered 01 to 09 - otherwise they'll be played in the wrong order.
4. Move all tracks to a common directory, and burn them so that they appear within your CD-ROM's root directory. Don't forget to 'close' your disc! A full CD-ROM will contain up to 650MB - which equates to a fair number of tracks!



Choose file... C:\MP3 Music\80s pop\Tracy Chapman\1 T

Songname: Talkin' Bout a Revolution

Artist: Tracy Chapman

Album name: Tracy Chapman

Comment:

Year: 1999

Genre: Pop

5. Reboot your machine in DOS playback mode. You'll find that albums are played in alphabetical order - with all tracks in the correct sequence. DAMP (the MP3 playback application) decodes the ID3 information of each track, and passes the artist and songname to the LCD screen. Tracks can be selected using the front panel buttons (refer to the July issue of 'Electronics and Beyond'.

COMMENT

by Keith Brindley

There's no such thing as a free lunch! It's an old adage, and one that everyone should remember in all walks of life. It was one of the first things I learned when I trained as a journalist. If someone offers you a freebie whether it's lunch, software, hardware, gadgets or money for nothing, then the first thing you should ask yourself is 'What's the catch?'

Nothing's free, of course, ever - and the term 'free' is usually just a euphemism for something else. That's why - as a journalist writing about Internet matters - I'm wary when Internet service providers tell me their Internet service is free. It may be free in the sense that use of access is not charged for, or that use of access and telephone calls are free, but then you have to ask yourself 'Well, if it is free, why am I being offered it for nothing?' In effect, 'What's the catch?'

There is a small but rapidly increasing number of Internet service providers that offer free Internet access and telephone connection. I've been playing around with a couple over the last month or so, and I've found that not all is at it seems. Not that any of these free Internet service providers are doing anything wrong. Indeed, anything that can reduce the cost of Internet access for the general public in the UK is a great thing!

No, instead, the problem is generally that any truly free Internet access service is inevitably popular. So popular that in some cases the Internet service provider might not be able to cope with demand. And that means that - particularly at certain times of day - the system is so busy that users often have trouble gaining access. For example, it's not unusual to find access unavailable (indicated by busy dial tones) around 6pm - the time when most users will have returned home from work, and want to connect to the Internet. At other times of day, access is more usually available at the first or second dial-up attempt.

This is all to do with Internet service providers' access lines of course - and in particular the number of modems they have to allow user access. Paid-for Internet service providers can afford to put in more modems, so their dial-up lines will be less busy. To put this in perspective, paid-for Internet service providers usually have a ratio of modems-to-users that allows access to most users at most times. There's always the odd occasion that more users than usual try to dial-up at the same time, because it's not economically feasible to provide a modem for every user but, overall, such Internet service providers find that busy dial tones don't often occur. The free access Internet service providers have an inherent problem installing the numbers of modems that they need to provide access at all times because users naturally tend to use the system a lot more because it's free. Indeed, it's not uncommon for users to dial-up to a free access provider and hang on the line indefinitely - even if it's not being used - simply because it is free. This is because they know that if they log off they might not be able to get back online as easily next time. On the other hand, users of paid-for Internet access providers tend to get off the line when they're not actually using the Internet, as they know the clock's ticking and they will be charged.

Of course, a lot of current problems are teething problems that will sort themselves out over time. As users become more familiar with free access, and become aware that the Internet can be accessed freely at any time, say, their use of the Internet will probably fall not rise.

So how do these pioneering free Internet services exist, if they don't charge for Internet access? In the main, their income is generated by charging users for non-Internet telephone calls, which have been bought at a discounted rate from BT. The idea is that if users make sufficient conventional telephone calls through their service, the income generated will pay for the free Internet usage, leaving a profit. To do this, users usually require a small converter box (usually called a Smart Dialler), with plugs into the BT master telephone socket. The box merely prefixes any outgoing telephone call with a few digits. The digits identify the call to the BT telephone exchange as a call to be charged to the free Internet service provider's account. It's really all quite simple, yet extremely effective.

There's a couple of alternatives to this method - the cable telephone and television companies. Theses of course have their own networks, so can provide customers with whatever priced Internet access they wish. For example, ntl has recently introduced its ntlworld system, which is a totally free Internet access service. As not all the country has yet been cabled, this would appear to be of benefit only to ntl's existing customers. However, ntlworld is interesting in that existing BT telephone users can take advantage of ntlworld, with an ntl Smart Dialler in the same manner as already described. As you might expect, the demand for ntlworld has been huge, and ntl is having problems getting all interested users online. For example, even though I'm an ntl customer, and although the service officially started on 12 April, as I write this in early June I haven't yet received my connection pack from ntl.

Whatever the teething problems though, free Internet access for all looks to be on the very near horizon, and getting closer daily. And, even though teething problems exist, being free is better than being charged. Despite its apparent high technology, the Internet itself is really just a technology in its infancy, and it has a significant way to go before it realises its potential. Part of realising its potential is free access to it. Summing up, while North America has a rocket powered Internet - due to free access - the UK (and most other countries) languishes with its steam-driven, paid-for, access. The pioneering free access service providers are all part of the move towards allowing the UK to compete in Internet technology. If we don't have free access, we'll simply never compete, and inevitably fall further behind.

The whole situation though, begs one simple question: if pioneering free Internet access providers (and ntl) can do it, why can't BT?

The opinions expressed by the author are not necessarily those of the publisher or the editor.

The prototype in 'stand-alone' MP3 playback mode. Sirocco speakers courtesy of Videologic.

MP3 Player UPDATE

PART 2

Martin Pipe completes the revision of his PC-based MP3 player project

In last month's issue, we described how the industry-standard Creative Labs Soundblaster 16 (SB16) - which forms the audio output device of the MP3 player project - could be improved. We detailed a replacement analogue output stage, and explained how an operating system-independent S/PDIF output could be added. The latter comes into its own if you want to copy MP3 songs onto DAT or Minidisc digitally, or simply want to listen to music through an audiophile-quality DAC. That said, the re-engineered analogue stage was found to significantly improve sound quality, and should suffice for all but the most critical applications. Subjectively speaking, the resulting soundcard is capable of better replay sonics than just about any consumer-level model. It even stands up pretty well against semi-professional types like Terratec's EWS64XL (which, by the way, isn't fully SB16-compliant in DOS mode). Combine these modifications, the software changes covered in the last issue and the original articles (March and April 2000), and you should have a stand-alone MP3 player of excellent quality.

All of that computing power 'under the bonnet' makes the system capable of doing a lot more than some of the stand-alone MP3-compatible players that are now becoming available. For example, you should be able to make your own MP3s from CDs or other sources. The config.sys and autoexec.bat files have been designed in such a way that Windows '98 can be loaded from a boot-up menu. In this mode, the unit will run the huge range of compatible audio editing, MP3 conversion and CD mastering tools. Indeed, the prototype now has a Creative 'CD-Studio' rewriter instead of the originally-specified CD-ROM drive. With appropriate software, the Creative drive gives the system an ability to produce regular audio CDs, as well as MP3 CDs, on cheap CD-R media. Not only does this bring it ahead of ordinary MP3 players, but it also makes it considerably more flexible than stand-alone audio CD recorders. Such devices won't edit tracks prior to burning or record/play MP3 discs - what's more, they require a special variety media that is more expensive than those sold for computer use.

The software provides much of this flexibility, and we'll be discussing how in this article - and a companion one on CD audio mastering in this issue. It has to be said that the average audio CD recorder is better-connected (in audio terms, certainly) than the average PC. The same comment thus applies to this system, which is - after all - a very specialised PC. Your typical stand-alone recorder will have SP/DIF and/or TOSlink digital inputs and outputs, as well as analogue line ones. Digital audio inputs are useful if you want to master from DATs, Minidiscs or DCCs. If you merely want to copy (tracks from) CDs, then the digital input isn't necessary with our computer-based approach - with CD audio recorders, it is of course a different story! Most modern CD-ROM drives and 'burners' support DAE (digital audio extraction), an are thus capable of 'ripping' CD audio trac to the hard disk as WAV files. We'll discuss how digital inputs can be added very cheaply later.

Modifying the SB16

As it stands, our project has only the standard SB16 line inputs. What's more, a careful listener through a good hi-fi amp and speakers will reveal that they're of mediocre quality. The line-level audio sign is routed through a considerable amount superfluous circuitry, including dozens of small-value electrolytic capacitors, 741-grad op-amps and, within the specialised CT174 mixer chip, a series of VCAs and analogue switches. No wonder that detail is masked, noise levels high and bass depth restricted We decided to re-engineer the analogue input along similar 'minimalist' lines to those described last month. The SB16's analogue-to-digital converter is contained within the same AK4501 device as the DAC as shown last month. The datasheet for thi device (which, on some Creative cards, is known as the CT1703) also mentions that anti-aliasing filters are built-in. These filters won't reject noise at 3.072MHz (and multiples thereof), but that won't be a problem with audio signals!

Replacing the SB16's analogue input circuitry is thus a fairly simple matter, and the circuitry required can be built up from standard op-amps (in this case, TL072s). As Figure 1 last month shows, the required input format for each stereo channel is differential. Pins 7 (-) and 6 (+) accept the left channel, while the right channel is fed into pins 5 (-) and 4 (+). The differential signals can be produced from the normal single-ended line input using the circuit described in Figure 1. Note that one of these circuits is required for each stereo channel. IC1, which has a voltage gain of just under 5, inverts the signal and feeds it to the chip's '-' input. The gain is sufficient to cope with a wide variety of signal levels. The inverted output is also fed to the inverting unity-gain buffer of IC2, which restores the signal to its original non-inverted state - it is then fed to the chip's '+' input. A 2.5V bias signal, required by the AK4501, is derived from 5V regulator IC2 and associated components. Note that the SB16 PCB tracks currently connected to pins 4 to 7 will need to be cut. The AK4501 is a surface-mounted device and the board layout rather dense - so be careful!

Level Monitoring

Some means of setting the input levels - and indeed monitoring them - would be a sensible idea when recording from the line inputs with programs like Syntrillium's Cool Edit (record, edit, replay, convert and save to a variety of file formats - including, with the appropriate plug-in, MP3) or Iomega's RecordIt (record and replay MPEG-1 Layer 2 audio). Although CoolEdit has a valuable software-implemented meter, the same isn't true of RecordIt. Remember that the maximum signal level during recording should correspond to 0dB - full-scale, or in s case a ADC hex output value of 7FFF - if e best possible dynamic range is to be hieved. We used 47k potentiometers, red up as shown in Figure 2. This pair of ts are mounted on the front panel. Figure lso details output and meter switching. e'll discuss the output switching shortly, t for now let's talk about those meters d the associated circuitry. We specified a ir of Velleman 10-LED VU meters (VF91Y) ne for each channel. To save on etalwork and internal 'real-estate', they re configured in a novel way. The LEDs pplied in the kit were discarded in favour a pair of 10-LED 'bars'. These were fitted hind the front-panel window provided for e LCD screen - refer to Figure 3. The vices were epoxied into position so that e tips of the individual LEDs were just sible from the top (left channel) and ttom (right channel) of the window. nother photo shows how the Velleman ards were mounted vertically on the side the case - connections to the LED bars ere made via 11-way ribbon cables.

The boards - shown in Figures 4 and 5 - ere made as per Velleman's instructions, cept that Minicon connectors were ldered into position instead of the LEDs. nother change is that the 220k preset V1, which sets the gain of IC1) is replaced ith a 470k type to increase sensitivity - the ason why will follow shortly. I based my isplay around scrap LED bars from an old erguson TV control panel - here, the athode and anode connections for each evice are isolated. A common-anode onnection was made in both cases. The olated connections allowed the LED bars be wired in such a way that both bars ead from left to right, despite the fact that ey are 'upside down' relative to each ther. Unfortunately, this won't be possible ith the obvious choice of LED bar sold by laplin (YH76H), because this employs a xed common-anode connection. Mount it ithout fouling the LCD module, and you'll nd that the indicator bars move in pposite directions! Two of the other levices available from Maplin are suitable, lthough they may require extra work. The ed DIL bargraph (BY65V) could be nounted to read vertically, but its 25mm eight requires additional metalwork. A ractical alternative is to horizontally 'stack' ogether several of multi-LED arrays - two ed dual-arrays (YH77J) and two red tri-rrays (YH78K) arranged side-by-side should uffice.

Back to the signal routing circuitry, etailed in Figure 2. A monitor selector switch (shown as S2 in Figure 2) determines whether the unprocessed input, or the utput from the modified SB16, is fed to the ine output and meters. The feeds for the SB16's modified line input and S2 are both taken from the wipers of the input level controls (shown as RV1 - left channel - and RV2 - right channel). S2, a 4-pole 3-way rotary type (FF76H), is analogous to the 'record/play' switch fitted to the earliest tape recorders. Two of its poles are used to switch the left and right audio signals between input and output, while the remaining pair determine which signals are fed to the meters. A series of 47k presets (RV2 to RV6, mounted on a piece of matrix board) are used to match the record and replay signal levels so that the meter levels tally with each other when switching from record to replay. These presets, plus those on the meter drive boards, were calibrated using the meter built into Cool '96 (available as shareware from several sites, including www.shareware.com). On the subject of meters, note that the S2's third position switches them out of circuit altogether - you might not want those LEDs blinking away distractingly when the system is, for example, playing MP3 files in its DOS mode.

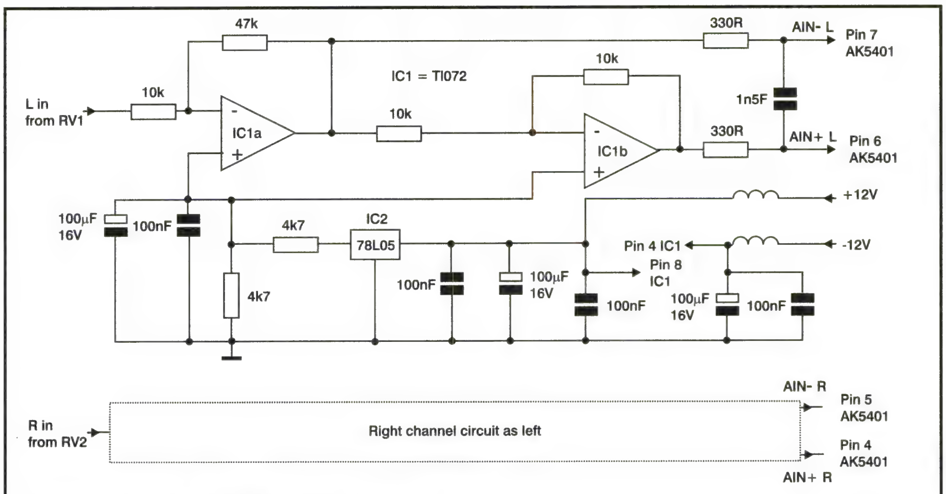


Figure 1. Modified SB16 analogue input stage

Digital Inputs

OK, that's the analogue inputs dealt with. But what about the digital ones? You might want to transfer recordings from DATs onto CD or MP3, but avoid any quality penalties incurred by having to go from digital to analogue and back again. The same considerations will apply if you want to make lossless digital recordings directly from a DAB tuner - or the modified DVB satellite receiver described in the February 2000 issue of 'Electronics'. All of these items of equipment are equipped with S/PDIF (coaxial) or TOSlink output terminals. Most of the cards with compatible inputs are very expensive - Creative's Soundblaster Live Platinum, for example, retails for around £200. There is, however, a cheap alternative - and its basis is a cheap soundcard known as the Audio Excel AV511. Look around computer fairs, and you should be able to pick up one of these cards, which is based around CMedia's CM8738 chipset, for £10 or so. OK, its analogue circuitry delivers fairly grotty results - but who cares? In the modified SB16, we have a card that's more than capable of handling the analogue side of the operation. The AV511's claim to fame is that it offers S/PDIF input and output, and what's more they're bit-perfect! As with other PCI cards, the AV511 only works under Windows 9x. No problem - in this application, the AV511 will be employed solely for digital audio mastering applications, nearly all of which require Windows anyway. To this end, the card is supplied with Windows '95/98 drivers, and a series of applications.

Mixer Software

Most important of these is the 'mixer', which replaces the one associated with Windows. From here, you'll be able to kill the unwanted (analogue) inputs to eliminate unwanted noise. In the mixer's 'advanced' menu - accessed via a button on the bottom-left - you'll be able to switch the S/PDIF input and outputs on or off, and select the S/PDIF signal output level (TTL or 1V). Other options, such as the S/PDIF invert and input signal level, don't work properly because the hardware doesn't support them. Inversion of the signal may be required for compatibility with some devices, but this can be achieved easily with hardware - we'll discuss the importance of this shortly. Another disadvantage is that you can't adjust the volume of the SP/DIF input, as you can with the Soundblaster Live. Some digital radio channels are frequently rather low in level (a pity, because they're not making the use of the full dynamic range). If you're making recordings, you could always boost levels using software. We'll explain how Cool Edit can be applied to the task in the CD authoring article in this issue. The AV511 was installed alongside the modified SB16, which is retained for working with analogue sources and DOS MP3 playback. The soundcard required is selected via the 'Multimedia' control panel within Windows.

The bargain-basement Audio Excel AV511 PCI soundcard, which forms a bargain digital audio I/O device. Although we've specified this card for our project, it can be used to add S/PDIF input and output to any device - the circuits of Figure 7 and 10 are still relevant.

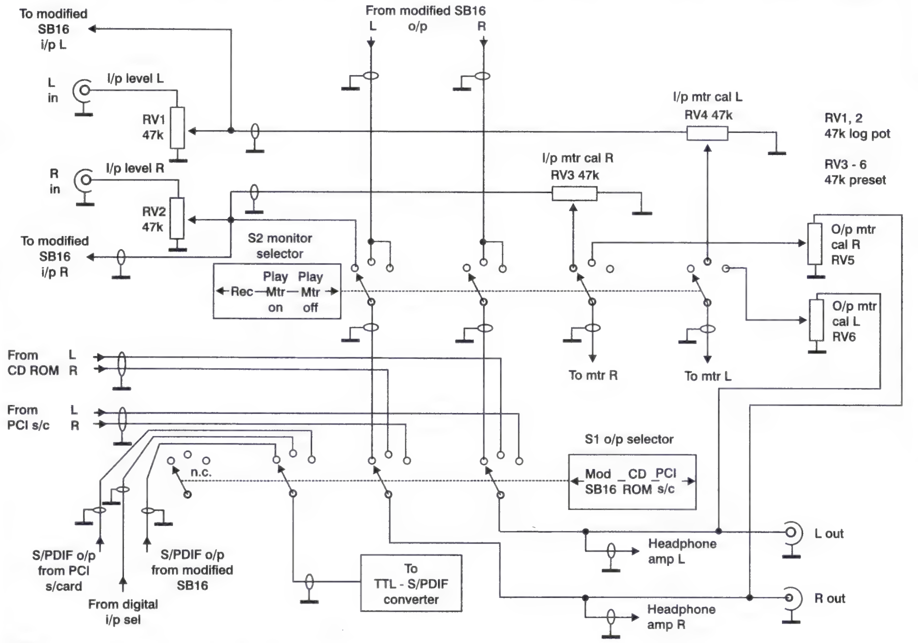


Figure 2. Input and output switching arrangement

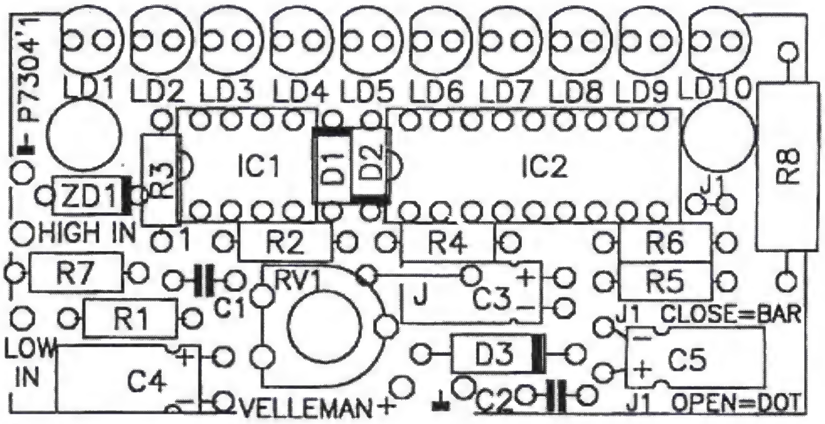


Figure 4. Velleman 10-LED VU meter PCB

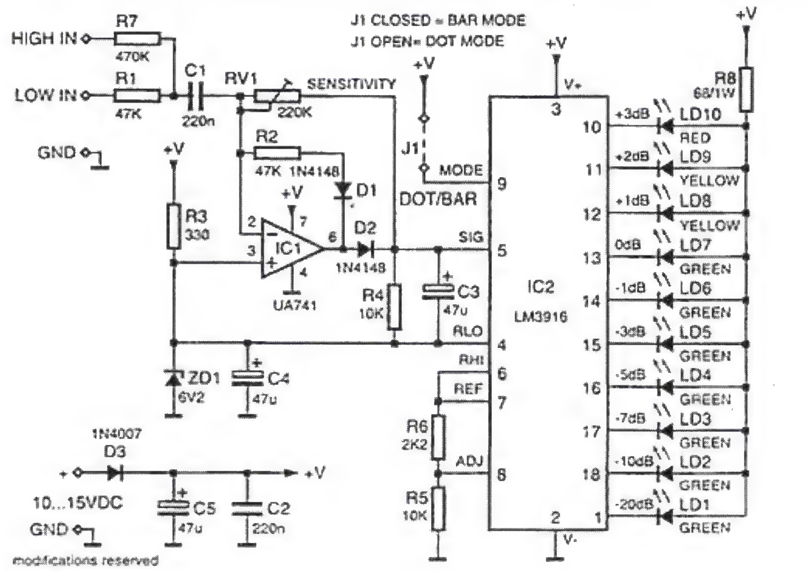


Figure 5. Velleman 10-LED VU meter circuit diagram

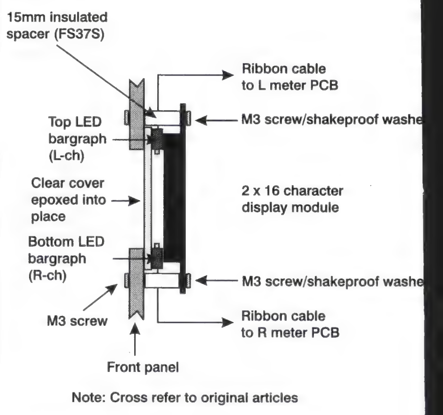

15mm insulated spacer (FS37S)
Ribbon cable to L meter PCB
Top LED bargraph (L-ch)
M3 screw/shakeproof washe
Clear cover epoxed into place
2 x 16 character display module
Bottom LED bargraph (R-ch)
M3 screw/shakeproof washe
M3 screw
Ribbon cable to R meter PCB
Front panel
Note: Cross refer to original articles

Figure 3. Fitting LED bargraphs to front panel

CoolEdit

Interestingly, Cool Edit's various incarnations (and other editing programs, no doubt) permit you to specify the desire peripheral directly, without having to mess around with Windows. Look for a menu tha says 'select wave device', or something similar. From here, you should be able to tell the software which card should be playing back, and which should be recording. The AV511's S/PDIF input and output are compatible with 44.1 and 48kHz sampling rates - good news for DAT devotees! Note that if you want to make audio CDs from 48kHz DATs, you'll need to convert the sampling rate to 44.1kHz. The same may also apply if you plan to convert those audio captures into MP3 files. Note that the CS8402A is only compatible with 44.1kHz sampling rates. In other words, if you try to play a 48kHz MP3 file in DOS mode, you'll get audio through the SB16's analogue outputs - but nothing from the S/PDIF output. Convert to 44.1kHz before compressing to MP3, if full compatibility with the player mode is required.

Card Connections

A 10-way header connector on the AV511, reproduced in Figure 6, contains the (TTL-level) S/PDIF inputs and outputs. Pin 4 is the output, Pin 5 the input, and Pin 6 a convenient ground. To integrate the card into the system, some extra hardware is required. The first is a circuit - shown in Figure 7 - that converts the low-level 1V coaxial S/PDIF signal to a TTL-level one compatible with the AV511. The ingenious circuit, developed by Heiko Purnhagen, was found to work exceptionally well. The active circuitry consists of two hex inverters (part of 74HCU04, IC1). Note that a TOSlink receiver module delivers a TTL-level signal, and will feed the AV511 directly. This device - shown in Figures 8 and 9 - is required if your source equipment is equipped with an optical output. We have specified the Sharp GP1F32R, because availability is good - albeit not from Maplin stores. Guess which company used to sell TOSlink modules, but does no longer? Note that many Sony MD and DAT decks are only equipped with an optical output, giving you no choice but to adopt the TOSlink input method unless you're prepared to make modifications to

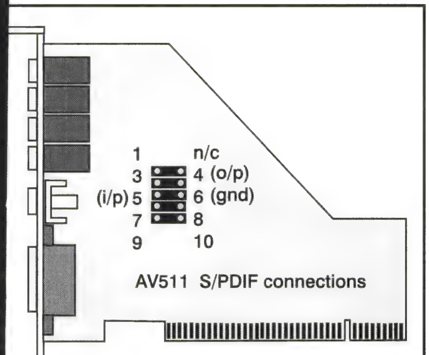
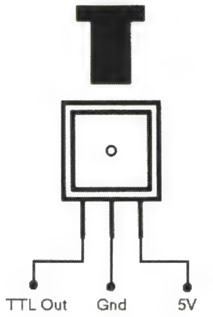


Figure 6. Pin-out details of AV511 header plug, which contains S/PDIF input and output signals.



Pin-out of Sharp GP1F32R TOSlink receiver module (Viewed from REAR of device!)

igure 8. Pin-out details for the Sharp GP1F32R TOSlink optical receiver module.

ur decks! Figure 7 also shows the rototype's digital input switching rrangements. Here, S3 - a 4-pole 3-way otary type (FF76H) - selects between the oaxial input, optical input and the rear-anel TTL-level S/PDIF output fitted to any modern CD-ROM and CD-R(W) rives. Two of the spare gates of IC1, and a hangeover switch, provide a S/PDIF input nverter. In my experience, the AV511 is very ussy about what's presented to it. If the olarity of the signal isn't what the card xpects, you'll get horribly distorted audio. licking the 'invert' switch should fix the roblem, which seems to vary from one igital source to another.

utput Arrangements

hich brings us neatly to the output rrangements. The AV511 has a coaxial /PDIF output on its mounting bracket, and he voltage level can be set - by the mixer's advanced' menu - to the required 1V. If ou're using the 19in. rack-mounted case riginally specified for the project, you'll ave to drill a hole on its rear to provide ccess to this socket. I wouldn't bother. letalwork hassle notwithstanding, the oaxial output is not isolated as per the /PDIF specifications. This could create roblems with earth loops. Interestingly the /PDIF output is duplicated on the header. Jsing the mixer, set the card to produce a TL-level output. The circuit given in Figure 0 will convert this to an isolated output of he required level. The transformer (T1) was alvaged from a scrap CD player, but one an be made from a 12.7mm diameter

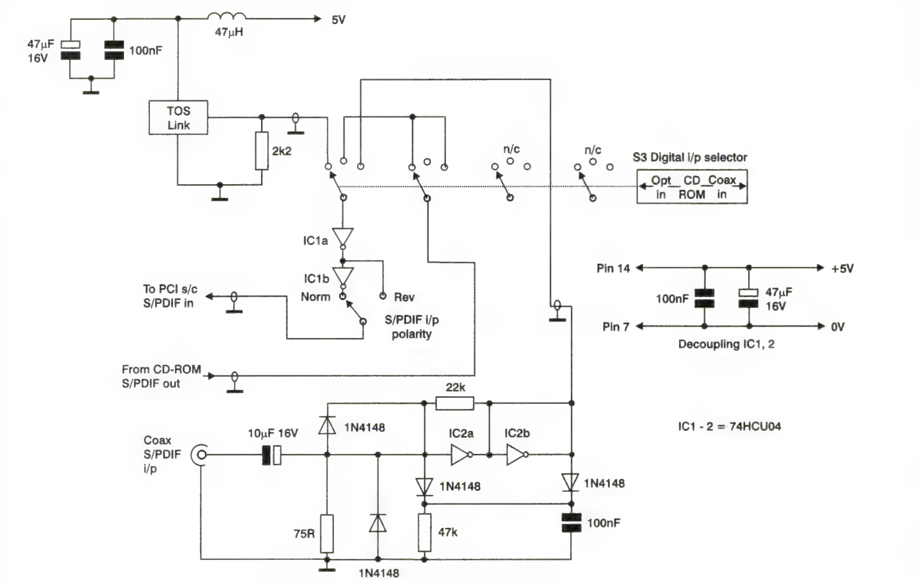


Figure 7. Digital input switching, and coax-to-TTL converter circuit

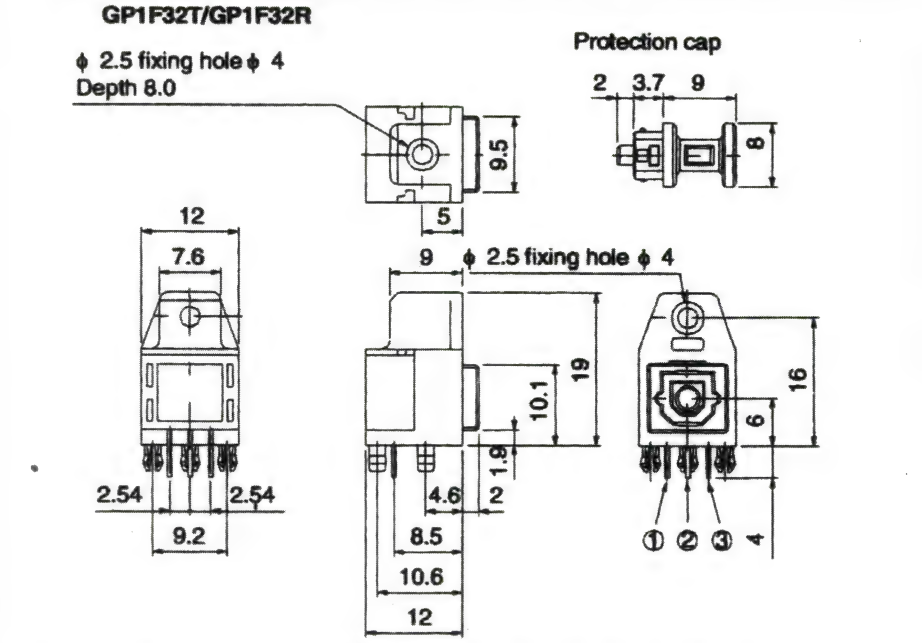


Figure 9. Mounting details for the Sharp TOSlink optical receiver and transmitter modules

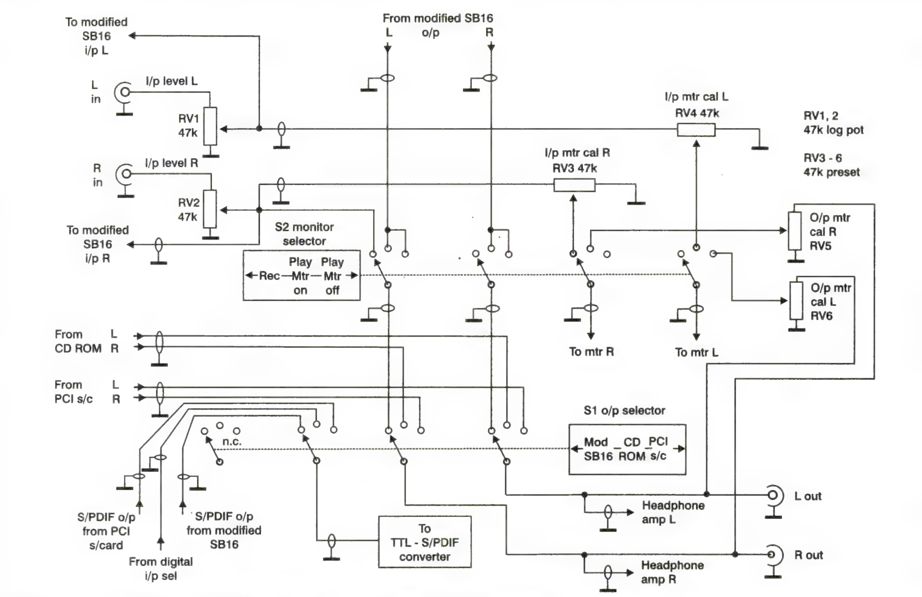


Figure 10. TTL-to-S/PDIF buffer and matching circuit

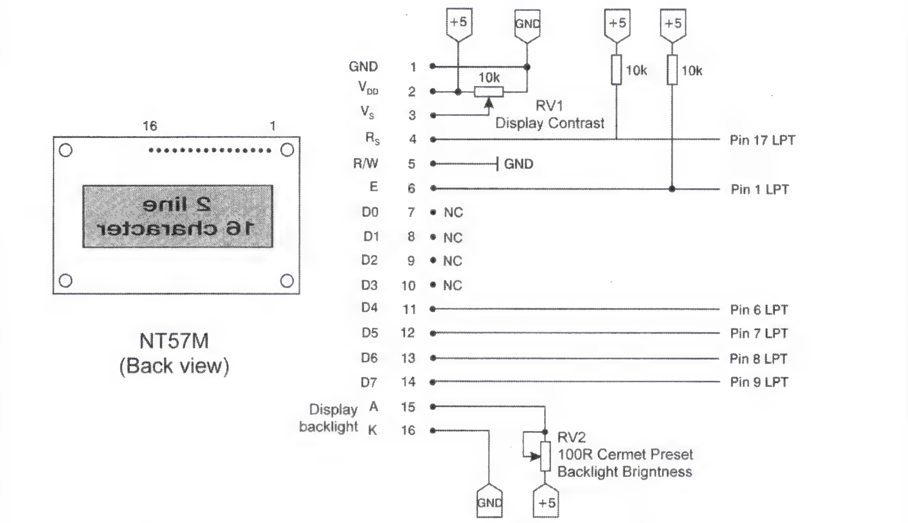
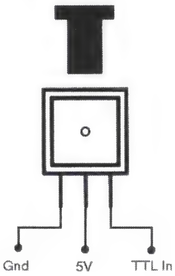


Figure 12. Wiring details for replacement 16 x 2 display module



Pin-out of Sharp GP1F32T TOSlink transmitter module (Viewed from REAR of device!)

Figure 11. Pin-out details for the Sharp GP1F32T TOSlink optical transmitter module

ferrite core. 20 turns are required on the primary side, and 4 on the secondary. Until very recently, Maplin sold a suitable ferrite (AN74R), but - as with many other useful items - the company has helpfully decided to discontinue them. If you don't want to take your CD player apart, you might be able to find one on a junkbox Ethernet card. Note that the Figure 10 circuit could also be used to add a coaxial output to TOSlink-only digital audio equipment. The required TTL-level S/PDIF, 5V and ground signals will all be found on the TOSlink connector.

If you have no luck finding a suitable transformer, the AV511's TTL S/PDIF output signal could be used to drive a TOSlink transmitter (refer to Figures 9 and 11) directly. Your player can then be connected to external equipment via an optical fibre cable. An advantage of the optical approach is that complete isolation is afforded. The CS8402A chip and CD-ROM S/PDIF outputs are also at TTL level. The output selector (S1) shown in Figure 2 will determine whether the S/PDIF output from the modified SB16, CD-ROM drive or AV511 is fed to the TOSlink module and/or coax circuit of Figure 10. The switch is yet another 4-pole 3-way rotary type (FF76H). As you can see from Figure 2, two of the switch's other poles simultaneously switch in the relevant analogue stereo outputs. Note from Figure 7 that the CD-ROM drive's S/PDIF output is not available when the digital input selector is set to deliver this signal to the AV511.

Conclusion

Implement all these changes, and you'll end up with a highly flexible and expandable piece of audio gear. We wish you many hours of happy recording and listening! Any future changes to this project will be detailed on the Web. I urge you to visit **www.digitalmods.com** regularly...

Display Module

The backlit LCD module (RB36P) detailed in the original March and April issues is, alas, no longer available from Maplin. However, the company continues to stock a suitable module (NT57M) which is compatible with the existing LCD driver. The wiring diagram for the new module is given in Figure 12. Although the device is pin-compatible, we include the drawing because some information was missing from the original! Note that the mounting arrangements are completely different to those of RB36P - as can be seen from the front and side-view drawings reproduced in Figures 13 and 14. This information, plus the original drawings, should allow you to provide a suitable front-panel cut-out and mounting holes.

Note

The Sharp GP1F32T TOSlink transmitter and GP1F32R receiver are available from Hero Electronics Ltd, which can be contacted on (01525) 405015. The company can also be contacted by writing to them at Hero Electronics, Dunstable Street, Ampthill, Beds MK45 2JS. As an alternative, you could e-mail hero@heroelec.co.uk. The cost of each device, inclusive of VAT and post/packing, is less than £10.

I have seen AV511 cards at various computer fairs - mine was acquired for £10 at the Picketts Lock radio rally a few months back. Central London-based computer dealer Morgan Computers was selling a Zoltrix version of the card for £20. Another company worth trying is Pivot Systems, which has been known to sell Audio Excel products. The company's telephone number is 020 8850 3939. Its Web site resides at **www.pivotcomputers.co.uk.** If you have no luck with conventional retailers, try a search on the Internet.

Neither Maplin Electronics nor the author can be held responsible if your soundcard or PC blows up - so be careful! The information in this article is provided on an 'as-is' basis.

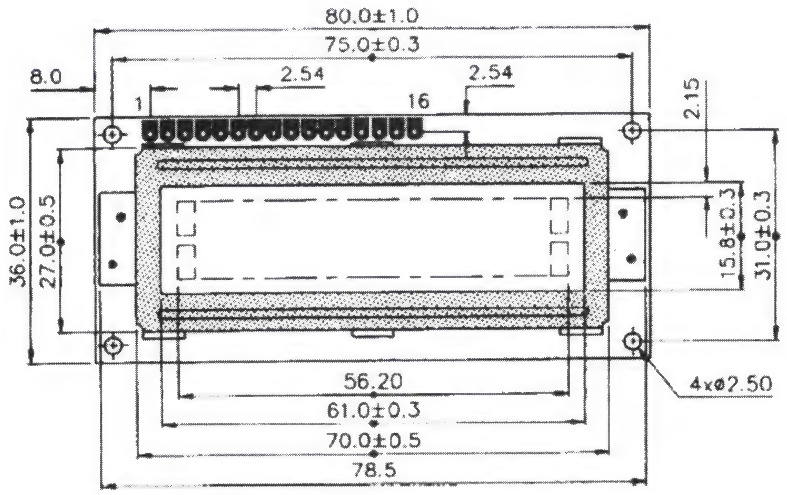


Figure 13. Front dimensions of replacement 16x2 LCD module (NT57M)

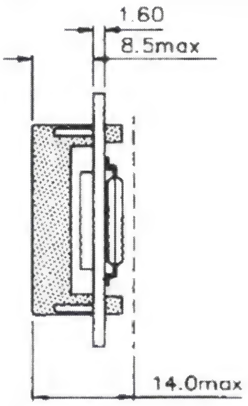


Figure 14. Side dimensions of replacement 16x2 LCD module (NT57M)

Beyond the SILICON MICROPROCESSOR

Mike Bedford concludes his look at the future replacement for silicon in the electronics industry

In last Month's article on Moore's Law, and the obstacles which lie ahead for semiconductor manufacturers, I made a rather disturbing assertion. If the experts are correct, it may not be possible to shrink the feature size of chips much beyond the year 2015 and beyond this time, further processor performance increases will be modest, at the best. What makes this so disturbing, of course, is that it's at odds with our expectation of a doubling in performance every two years. But although this seems so contrary to our experience, there are so many potential roadblocks ahead - some concerned with technology, some with economics, some with the fundamental laws of physics - that we really do have to take the possibility seriously. And for a number of researchers this involves investigating alternatives to silicon integrated circuits. After all, computers haven't always been based on silicon chips - earlier generations of computers used valves and then discrete transistors - so why should we expect that microprocessors will remain dominant forever? Some of this research is evolutionary, in much the same way that valve computers evolved into transistor computers which, in turn evolved into computers using small scale integrated circuits and eventually microprocessors. However, other strands of research are concerned with revolutionary technologies, as different from today's computers as today's computers are from the slide rule or the mechanical adding machine.

Evolution

Evolutionary changes to the basic silicon semiconductor are, in fact, already taking place in an attempt to overcome some of the problems associated with the ever decreasing feature size. As we saw last month, one such change is the gradual changeover from conventional aluminium to copper interconnects. This change, which has already been introduced on the PowerPC and will be introduced by Intel for the 0.13 micron process, is to overcome the resistivity of the increasingly narrow tracks of the interconnection layers. But this is really just fine-tuning - much more radical changes are going to be needed if that roadblock is to be averted.

Another possible evolutionary change, albeit one which is more fundamental than a move to copper interconnects, would be the pensioning off of silicon in favour of another semiconductor material such as Gallium Arsenide, GaAs. My reason for describing this as evolutionary is that we're still talking of semiconductors built into an integrated circuit but there are some possible benefits to be had from such a change. As someone with an interest in electronics, you've probably read about GaAs, indeed this is a technology which could be applied across the board, not just for processor or memory manufacture. Because GaAs is, therefore, a reasonably familiar technology, I won't dwell on this to any length but no feature on future trends in computer hardware could be complete without a brief mention. And although we haven't seen GaAs in mainstream processors yet, the supercomputer industry has already embraced the technology and has reaped benefits in so doing. If you do already know something about GAs semiconductors you'll know that they offer the possibility of higher speed operation than an equivalent silicon device. Needless to say it's not all plain sailing for GaAs and one of the major drawbacks is that the thermal conductivity is much lower than that of silicon and this would make heat dissipation more difficult. We saw last month that getting rid of the waste heat is one of the potential show stoppers for further miniaturisation of silicon semiconductors so the benefits to be gained from GaAs would have to be pretty impressive in order to compensate for this drawback.

Really that's all I have to say about evolutionary new technologies. Not because there's nothing more to be said - far from it - but because the revolutionary new technologies make a much more interesting story. The likelihood of any of these revolutionary technologies making the big time and shaping the future of computing is remote. Indeed the evolutionary technologies are more far likely to come to fruition. However, the evolutionary technologies are likely to be just stop-gap measures affecting the short to medium terms and providing a modest boost in performance. Some of the radical new technologies, on the other hand, hold out the promise of dramatic gains in performance and, should they come to into being, could affect the future of computing for decades if not for centuries.

Diodes from Spinach

It's got to be said that we owe a lot to plants. Without the photosynthesis that takes place inside them, this world would be devoid of carbohydrates and without carbohydrates it would be devoid of life. Photosynthesis, of course, is the chemical reaction that takes place in all green plants converting carbon dioxide and water into carbohydrates using sunlight as the energy source. However, according to Elias Greenbaum of the Oak Ridge National Laboratory in Tennessee, the powerhouse of life may soon become the driving force behind a new generation of computers.

Biologists talk about tiny chlorophyll-containing reaction centres deep in the cell structure of green plants. It is here that the sun's energy is converted into the chemical energy that is stored in carbohydrates, a process that takes place through the transition of electrons. Furthermore the reaction is structured in such a way that the reaction is non-reversible and this means that the electrons can pass in one direction only, just like a semiconductor diode. Not only this but these are diodes which are just 7nm long - that's twenty times smaller than the smallest conventional diodes - and the passage of an electron is measured in pico seconds. As one of the most fundamental building blocks of digital circuitry, the reaction centre diode might just, one day, lead to photochemical OR-gates and AND-gates, and ultimately to complete computers.

Greenbaum and his colleagues are still some way from this goal. Currently, the team has managed to isolate these reaction centres from spinach and has proved that they do, indeed, behave like diodes. They have also managed to deposit the diodes onto a gold wafer and align them all in a single direction, a first step toward assembling them into a working circuit. One of the biggest challenges, though, is to find a way of connecting the reaction centres together into a circuit - something that Greenbaum believes may be possible using carbon nano-tubes. This, of course, would be a radically different approach from today's method of manufacturing integrated circuits. Rather than the top-down approach of carving the circuit out of a slab of silicon, the circuit would be built, bottom up, from tiny components.

The Optical Alternative

Strange as building up processors from tiny reaction centres isolated from spinach may seem, though, it has to be admitted that we're still not talking of something radically different from silicon chips. Certainly the raw material is very different as is the manufacturing method but this would still be a processor built out of electronic logic gates which would be similar in its operation to a Pentium III. So let's now start out tour of technologies, which are very different indeed.

When discussion turns to super-computers of the future, the semi-technically-literate man in the street will generally think in terms of an optical computer. This is strange since there really isn't too much research going on into this subject today. There has been lots of research in the past but today the concept of an optical computer is largely discredited. Or to be more accurate, the idea of a general-purpose optical processor, the equivalent of today's electronic microprocessor, is all but forgotten about. Research into optical computing continues but mainly for niche applications, frequently connected with image processing, rather than in the aim of producing something which will power the next generation of PCs. The difficulty in producing an optical computer lies in the difficulty of devising an optical switch, the optical equivalent of a transistor. Certainly it's possible, indeed it's trivial, to come up with an electro-optical switch in which an electrical signals switches an optical beam. And whereas logic devices have been built this way, most researchers would argue that this offers few, if any, benefits over a fully electronic circuit. Scientists have also discovered crystals that exhibit non-linear properties and thereby allow one light beam to switch another light beam. The difficulty with this approach, though, is that the switching beam has to be generated by a high power laser. This is not energy efficient and heat dissipation is a major problem.

Figure 1.

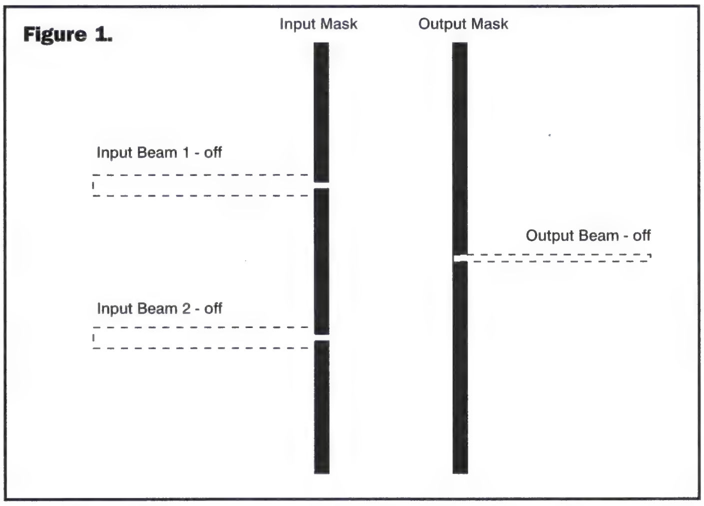
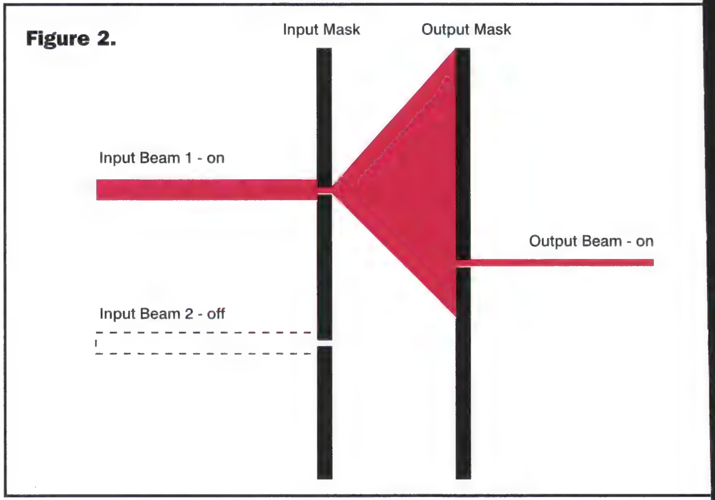


Figure 2.



Let me now introduce you to the CyberDyne Computer Corporation of St. George, Utah and their photonic transistor, the rights to which had been acquired from the Rocky Mountain Research Center. In the next paragraph I'll say something about how the photonic transistor is supposed to work and what it could offer the world of computing. Before I do that, though, I really need to sound a note of caution concerning this. Personally, I can't quite make out CyberDyne. I first came across their Web site, and that of the Rocky Mountain Research Center, over two years ago. The claims are impressive, patents applications have been filed, and there's talk of developing a fully operational photonic computer in the near future. Yet as of today, the Web sites are still there, but the information is little changed, despite the photonic transistor dating back to 1989, an the photonic computer is no closer. Furthermore, I can find no other respected authority on optical computing who even makes mention of the concept. So are thes guys mad or are they brilliant? And if they'r brilliant, why has nobody else taken notice? I'll leave that for you to ponder as we take look at the photonic transistor, a concept which, I have to admit, begs the question " it's so simple why did nobody do it before and why are we not all using it in our PCs?"

First of all the rhetoric. Photonic transistors are capable of switching a beam of light in 30 femtoseconds, that's 30 millionths of a nano-second compared to a one nano-second switching of a 1GHz processor. The company believes that a one femtosecond switching speed would, ultimately, be achievable. To quote CyberDyne "The light used to turn these transistors on and off is produced by tiny lasers that operate at very low energy levels, producing considerably less heat than electronic transistors. Furthermore the transistors are made from glass or plastic holograms so, compared to non-linear crystals, they are cheap to manufacture. These transistors can be arrayed to mimic electronic functions to produce data processors, memories, video displays, telephone fibre optic switches or any other electronic-like product."

But how does a photonic transistor actually work? It's all to do with interference

Figure 3.

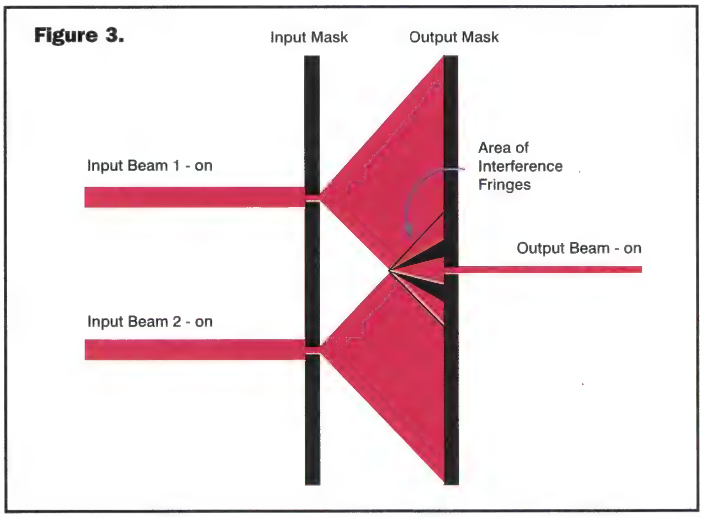
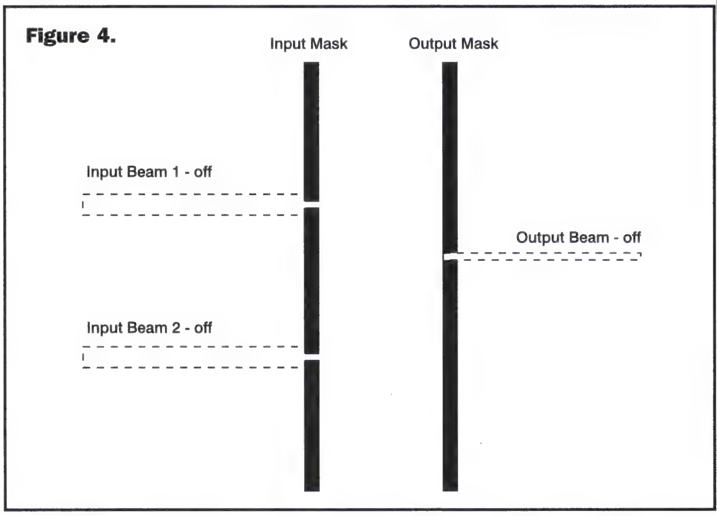
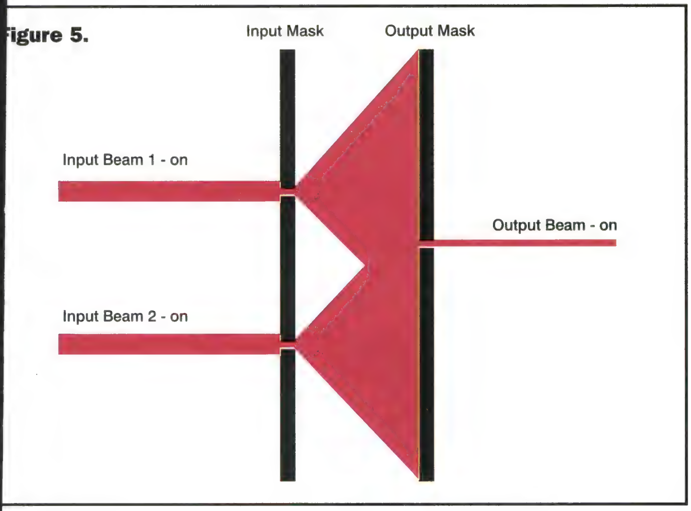


Figure 4.





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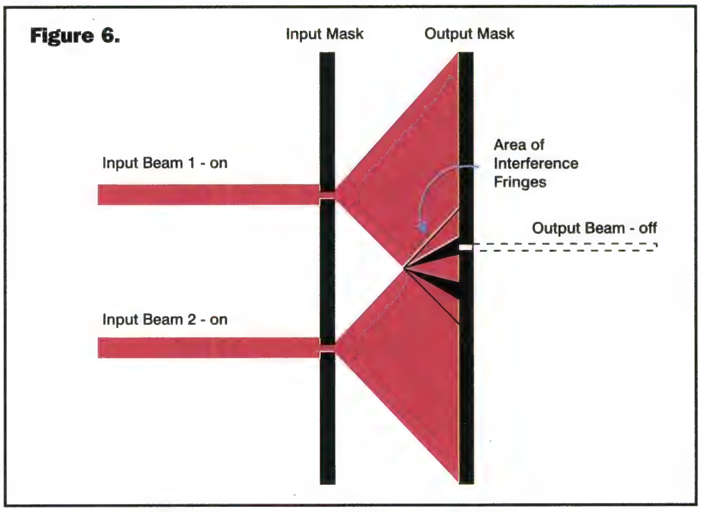


Figure 6.

nges like the ones we had demonstrated school physics lessons by the well-known ung's Fringes experiment. If you shine o beams of monochromatic light, derived m the same source using a pair of slits, to a flat surface, the two beams will erfere to produce alternating light and rk fringes. The light bands are produced constructive interference (i.e. where the o beams are in phase) and the dark bands destructive interference (i.e. where they e out of phase). With that bit of background hind us, let's take a look at Figures 1, 2 d 3 which are of a photonic transistor hich mimics an OR gate. Note that the hrase "photonic transistor" is really mething of a misnomer. Rather than this ing just a transistor it's actually a logic te and other variants of the photonic ansistor exhibit different logic functions as e'll see.

In Figure 1, we see what happens when either of the input laser beams is on. The utput mask receives no illumination so no utput emerges from the back of the mask. Figure 2 just one of the input beams is n. The output mask is illuminated niformly and so light passes through the it to produce an output beam. Clearly if we ere to arrange for the other input beam to e the only one which was on then we ould still get an output. In Figure 3 both nput beams are on and, as with Young's xperiment, the output mask is illuminated ith alternate light and dark interference inges. However, the slit in the output mask orresponds to an area of constructive nterference so light passes through and we ave an output beam. To summarise, herefore, we get an output if either or both f the input beams are on but not when oth are off. This is the operation of an OR-ate. It doesn't require a large change to urn this OR gate into an XOR-gate, that is n exclusive OR gate. In fact, the only hange is to the position of the slit in the utput mask. Figures 4, 5 and 6 show the hotonic XOR-gate with no inputs, one nput beam on and two input beams on espectively. The operation with no input eams and one input beams is the same as hat of the OR-gate. However, since the slit n the output mask is now in an area of lestructive interference, no output is produced when both input beams are on. The end result is that we get an output if one but not both of the input beams is on - this is the exclusive OR function. Using exactly the same configuration but having one of the input beams turned permanently on, we end up with a single input device which, in fact, operates as an inverter. XOR-gates alone are sufficient to build any logic function so this clearly lays the foundation of a universal computing device.

The Travelling Salesman

In an age when we're told that computers can do just about anything if we can make them fast enough, it's a sobering thought that some problems are officially non-computable. Examples of traditionally non-computable problems are "Does God exist?" and "Will lightning ever strike at National Grid Reference SD0125497537?" And it's not only problems like this, which common sense tells us can't be answered by computer, that are problematic. For example, Alan Turning, one of the fathers of computing, proved that it's impossible to write a computer program to determine whether another computer program will ever terminate with a given set of input data. But there's another class of problem which, despite the fact that we can easily devise an algorithm to solve it, in the general case it's not a practical proposition to do so. A classic example is the travelling salesman problem - let's take a look.

The travelling salesman problem asks the following question. "Which is the shortest route between a number of named cities?". In some cases, and with comparatively few cities, for example London, Glasgow, Aberdeen, Manchester, then the answer is obvious - London - Manchester - Glasgow - Aberdeen. In the general case, though, it isn't. Take a look at Figure 7 and I think you'll agree that it's not immediately obvious which sequence you should visit these cities to achieve the shortest round trip. Nobody has managed to come up with a solution other than the obvious one of adding up the total distance for each of the permutations and taking the lowest total. The snag, though, is that the number of permutations can be quite large and that it increases rapidly as the number of cities increases. For the example given in Figure 7 there are no less than 362,8800 possible routes and if we increase the number of cities to, say, 15, the number of possible routes is a touch over 87 billion. Now let's assume that we can evaluate one million routes per second. It would take 24 hours to come up with the answer. OK, that's a long time but if it saves a day every time your army of salespeople go on a sales trip I guess it's worthwhile so let's say that it's feasible to computer an answer to the problem. However, let's now assume that it becomes necessary to visit one more city, the number of permutations, and hence the computing time needed, increases by a factor of 15 to a couple of weeks and adding yet another city would increase it to 32 weeks. If we add another city we'd be talking of 11 years. Clearly processors will continue to get faster but, even if we don't encounter that brick wall we talked about last month, they're only doubling in speed every two years. In other words, the increase in processor speed will never allow us to cope with more than, say, 20 cities at the most. We know how to solve the problem but, in the general case, it's not feasible to do so. To stand a chance of solving problems like this, therefore, we

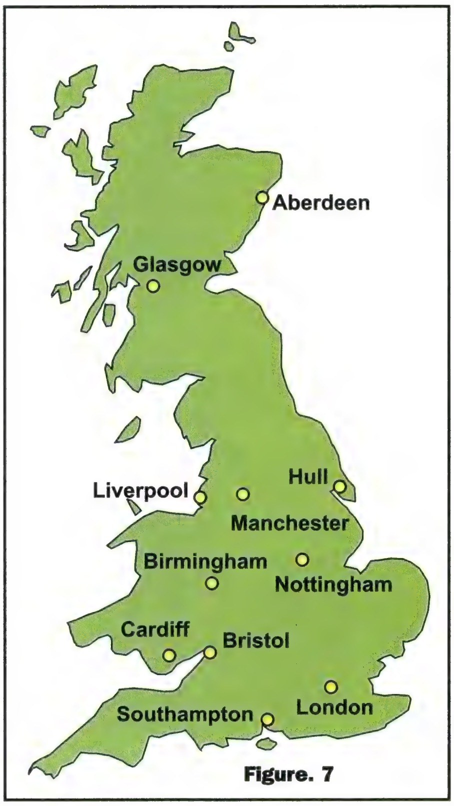


Figure. 7

need a completely new type of computer. One such computer is based on the principle of quantum processing.

Quantum Processors

OK, let's start off with a warning - this stuff is weird, very weird indeed. There's a good chance you won't understand it, in fact to be honest I don't really understand it. We're in good company, though. Nobel prize winning physicist Niels Bhor once commented, "anyone who can contemplate quantum mechanics without getting dizzy hasn't properly understood it". Nevertheless, understand it or not, hopefully I'll communicate something of this fascinating, albeit incomprehensible, field and give you a feel for the phenomenally powerful computers which could utilise quantum mechanics.

We've already mentioned Young's fringes as part of our discussion of the photonic transistor. Another famous experiment used much the same set-up except that the light source emitted just a single photon at a time. Viewing this classically we'd have to assume that each photon goes through one slit or the other and, accordingly, that interference fringes would not occur. The strange fact is, though, that Young's fringes still do occur which would seem to suggest that each photon actually passes through both slits and is therefore in two places at once. This strange property of being in two places at once or in two different states at the same time is the quantum mechanical property known as superposition. And whereas superposition is totally counter-intuitive, basically because it doesn't occur with a significant probability for large objects, is perfectly natural if we concern ourselves only with fundamental particles such as single photons or electrons.

Now let's assume, for the moment, that we can build a computer which operates on particles which can be superimposed. In one state this particle will represent a zero, in its other state a one, and when it's in a superposition it represents both zero and one together. These quantum mechanical bits are referred to as qubits. Now if a single qubit can store two different values at once, then a qubyte can store 256 values at once (see figure 8.)and a register of 16 qubits can store 65,536 values at the same time. Not only that but if it can store 65,536 values at once then it may be feasible for it to perform some calculation on all 65,536 values in the time it would normally take to carry out a calculation on a single value. This phenomenon is referred to a quantum parallelism and is demonstrably more powerful than conventional parallelism. Because the degree of parallelism increases exponentially with the size of the quantum computer rather than linearly, problems which increase in complexity exponentially, like the travelling salesman problem, suddenly become computationally feasible after all. Sounds amazing, and so it is. Unfortunately, a practical quantum computer is a long way from reality as there are some very significant hurdles to be overcome.

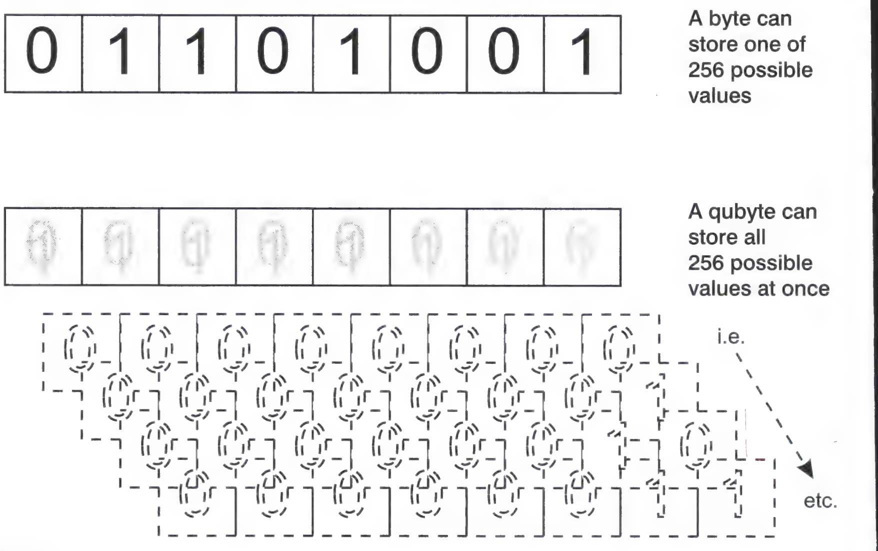

0 1 1 0 1 0 0 1
A byte can store one of 256 possible values
A qubyte can store all 256 possible values at once
i.e.
etc.

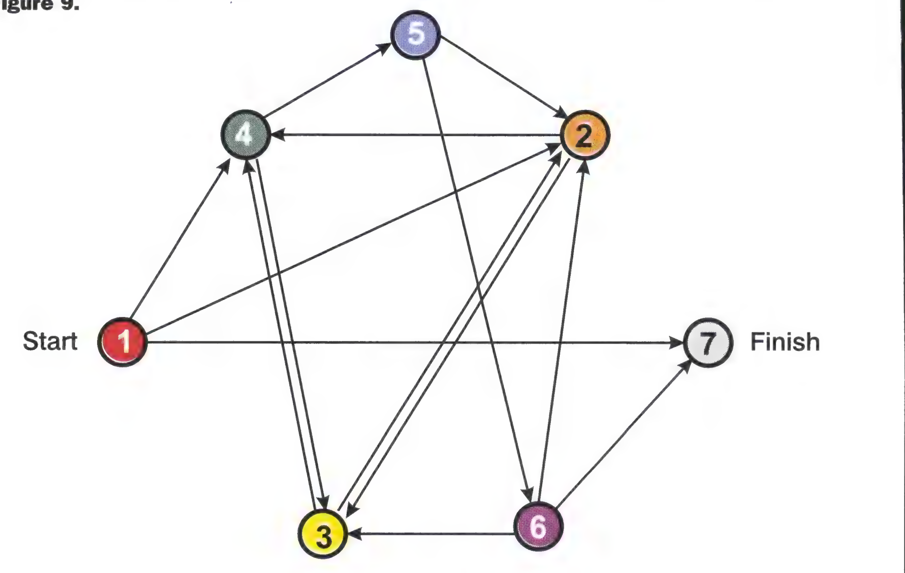
Figure 8.

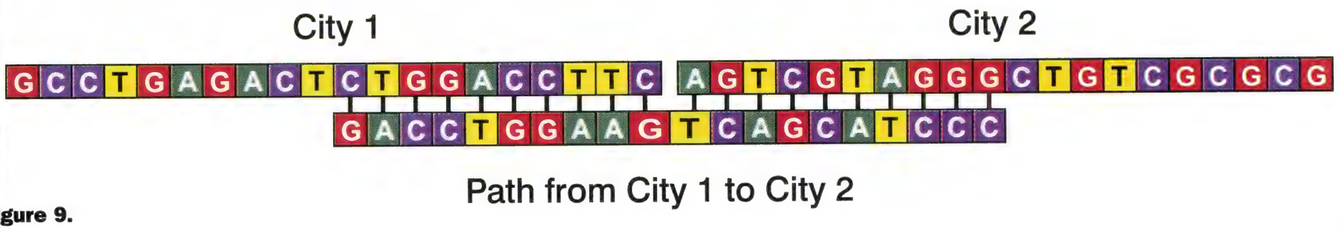
The first difficulty is the one of obtaining the result of a massively parallel quantum computation. The result of reading something that is superimposed causes the superposition to be destroyed. So although a quantum computer might actually carry out a huge number of calculations at once, as soon as you try to read out a result the superposition will collapse that is all the superimposed qubits will become either ones or zeros, not both. So you'll only actually end up with s single result. But not only will the result collapse to a single value, if you then try to read the value in the input register you'll find that this has also collapsed to a single value - the value corresponding to the result read out - so it will appear that the computation has only been carried out on a single value. This is due to as bizarre sounding effect called entanglement. I won't even attempt to describe how this problem is overcome - suffice it to say that it requires a very convoluted way of thinking to devise algorithms for quantum computers. And the second problem is the physical one of how to build a quantum computer - a problem that becomes increasingly difficult as the number of qubits increases. The snag is, apparently, that just as deliberately reading the data in a register of qubits destroys the superposition, unintentional interaction with the outside world can also produce decoherence as it's called. Qubits can all to easily give up their information so destroying the superposition. Furthermore the likelihood of this happening increase with the complexity of the computer and with the number of operations carried out. So far about 100 logic operations have bee carried out on two qubits and ten operations on seven qubits. Estimates are that a computer which could do useful computations on ten qubits is ten years away and one which can operate on one hundred qubits (carrying out more operations in an instant than there are atoms in the known universe) is 100 years away.

DNA Computing

The reason that a quantum computer is so powerful is that the number of computations it can do in a given time rises exponentially rather than linearly with the size of the hardware. With all conventional computers the power increases linearly with the amount of hardware which is why the traditional approach will never keep up wit

Figure 9.





igure 9.

blems like the travelling salesman which uire an amount of number crunching ich rises exponentially with the size of problem. Our final possible model for ure computing is a massively parallel one one for which, unlike the quantum mputer, the power is directly pportional to the amount of hardware. wever, since it's so easy with this hnique to have a vast number of ocessing elements, a vast amount of work n be done at once. Even this approach l eventually run out of steam on mputationally unfeasible problems like travelling salesman but the point at ich this happens will be far beyond the int at which a standard electronic mputer runs out of steam. What I'm king about is a DNA computer, one that erates by carrying out chemical reactions.

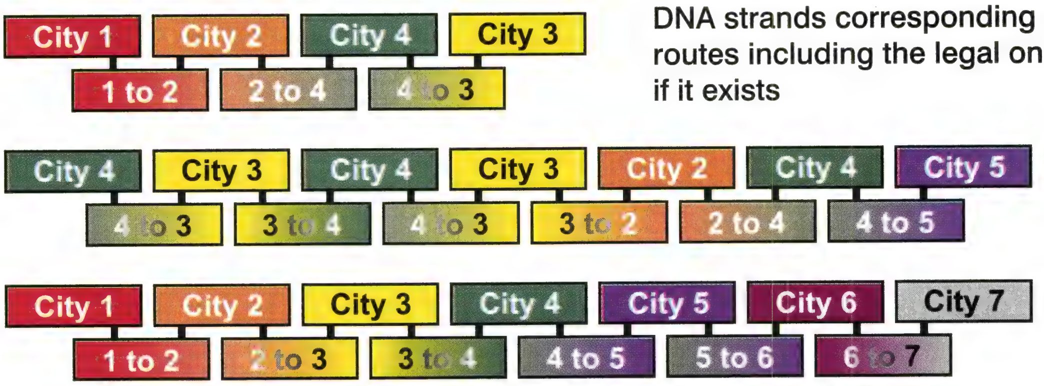
The first problem to have been solved in e test tube is the Hamiltonian Path oblem, one which, like the travelling lesman problem, has an exponential lationship between the size of the oblem and the number of computations ed to get an answer. This problem is to etermine a route, if one exists, between a umber of cities, visiting each one of them nce and only once. The problem specifies e starting and finishing cities and what aths - together with the permissible irection of travel - existing between the arious cities. The version of the amiltonian Path problem chosen by eonard Adleman of the University of outhern California, who first demonstrated he technique of DNA computing, had even cities and 13 paths. It is shown in igure 9.

Adleman's experiment made use of DNA nolecules. DNA is a very large molecule vhich is, in fact, a string of basic building lock called bases. There are, in fact, just our different bases - adenine (A), thymine T), guanine (G) and cytosine (C) - but ecause DNAs contain so many of them, the umber of possible permutations is huge. The other thing we need to know is that strands on DNA link up to form the familiar double helix if, and only if, the sequences of bases allows it. Specifically A will link with T (the complimentary base to A) and G with C (the complimentary base to G). So, for example, the DNA strand defined by the sequence CAGT will link with GTCA but with no other strand. So, back to the Hamiltonian Path problem - each city was represented by a strand of DNA 20 bases long. The sequences were chosen pretty much at random, in fact, so long as they're unique and they won't link up with each other, it really doesn't matter what sequences are used. Paths between the cities were also represented by DNA strands. The strands were also 20 bases long but, unlike the cities, they were not random. Instead these 20 bases correspond to the complements of the two cities joined by the path in question up to the half-way point. If this verbal description is confusing, Figure 9 should help. The experimental procedure involved allowing a few grams of the DNA strands corresponding to each of the seven cities to react with a few grams of the DNA strands corresponding to the 13 paths. Since even a few grams contains millions of molecules, the result will be a mixture of DNA sequences corresponding to all possible routes as shown in Figure 10.

This reaction occurs in a matter of a second or so - a long time in computing terms but not when we consider how many routes have been tried out. Clearly not all the routes which have been tried out, and hence for which DNA sequences have been produced, will be valid answers. Some will start or end at the wrong city, some will miss out some of the cities, and some will visit cities more than once. So the next stage of the process is to sift out the legal ones. This is carried out by performing further chemical reactions. So, for example, the first reaction might be to extract all those DNAs which start and end with the correct cities. The next might be to extract from those that remained, all those which pass through seven cities. And the final step may be to extract from those DNA sequences the ones which have no duplicated cities. If anything is left at the end of the sifting process, it's the DNA sequence corresponding to the answer. So finally, the order of the bases, and hence of the cities, is determined by the usual methods of chemical analysis. Ironically, in view of the fact that the actual calculation took only a second, Adleman took about a week to perform the subsequent sifting out and analysis of the final DNA sequence to obtain the correct answer. That result is, in fact, the order in which I numbered the cities in the illustration of the problem. This is early days, admittedly, but clearly DNA computers have shown their potential.

Optical, Quantum or Molecular?

So we've seen three possible methods of computing, all very different from electronic computing and all with vast potential. But which of these technologies is likely to give us the computer of 2050? At the moment I'd have to say it's anyone's guess. In fact, despite the potential roadblocks to the further development of silicon chips, I don't believe we can rule out electronic computers either. Perhaps the spinach computer might come to the rescue here. Also I'd have to say that optical, quantum and molecular technologies probably aren't the only options which might be dreamed up before silicon comes to the end of the line. So in marked contrast to the rather downbeat way in which we concluded last month's article on the future of Moore's Law, I believe we have every reason to conclude this article on an upbeat note. Perhaps your dreams of even faster computers beyond 2015 may not be over-optimistic after all.



The chemical reaction generates DNA strands corresponding to all routes including the legal one if it exists

Figure 10.

Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

August 2000

28 Aug. Computer Fair, Bournemouth International Centre, Bournemouth. Tel: (01342) 718 699.

September 2000

3 to 5 Sept. European Computer Trade Show (ECTS), Olympia, London. Tel: (0208) 742 2828.

10 to 13 Sept. PLASA - Light & Sound Trade Show, Earls Court, London. Tel: (0207) 244 6433.

13 to 14 Sept. OnBoard - Electronics Assembly Exhibition, Olympia, London. Tel: (01799) 528 292.

13 to 14 Sept. ECIF - Electronic Components Industries Fair, Olympia, London. Tel: (01799) 528 292.

17 Sept. National Vintage Communications Fair, NEC, Birmingham. Tel: (01392) 411 565.

19 to 20 Sept. Call Centre Expo, NEC, Birmingham, Miller Freeman. Tel: (0208) 742 2828.

21 to 24 Sept. Live - Consumer Electronics Show, Earls Court, London. Tel: (0208) 742 2828.

22 to 23 Sept. Leicester Amateur Radio Show, Donington Exhibition Centre, Derby. Tel: (01455) 823 344.

26 to 27 Sept. Business Systems Show G-MEX Centre, Manchester. Tel: (07000) 464 336.

26 to 28 Sept. GIS - Geographic Information Systems Exhibition, Earls Court, London. Tel: (0208) 742 2828.

27 to 28 Sept. Communications for Business, Barbican Centre, London. Tel: 01923 676 867.

October 2000

3 to 5 Oct. Coil Winding 2000, NEC, Birmingham. Tel: (0207) 417 7400.

4 to 5 Oct. Softworld Accounting & Finance, NEC, Birmingham. Tel: (0208) 541 5040.

9 to 11 Oct. TMA33 - Telecommunications Managers Association Exhibition, Stakis, Metropole, Brighton. Tel: (01372) 361 000.

11 to 12 Oct. SIT - Small Business IT Show, Bournemouth International Centre. Tel: (01934) 420 365.

11 to 12 Oct. TEST - Electronic Testing Exhibition, NEC, Birmingham. Tel: (02476) 230 333.

11 to 12 Oct. Webmaster - Web & Internet Show Olympia, London. Tel: (01256) 384 000.

11 to 12 Oct. JAVA - Computer Software Trade Exhibition & Conference, Olympia, London. Tel: (01256) 384 000.

17 to 18 Oct. Property Computer Show, Barbican Centre, London. 01273 836 800.

18 to 19 Oct. PHOTONEX/FIBRE EXHIBITION, NAC, Stoneleigh, Coventry. 01932 866 766.

25 to 26 Oct. Accounting IT, Business Design Centre, London. Tel: (0207) 221 1155.

24 to 25 Oct. OSPMA FieldComms - Industrial Networking Show, Telford International Centre. Tel: (0207) 417 7400.

31 Oct to 2 Nov. Voice Europe Olympia, London. Tel: (01244) 378 888.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?

Internet Insiders Give 'Thumbs Down' to Government's Commitment to UK.com

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Whether you're a dot com or re-inventing your business to fight them off, you don't have a millisecond to lose. If you're not busy transforming the way you do business, you can bet that someone else is.

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May 23-25, Tue-Wed 10am - 5pm, Thur 10am - 4.30pm

It's big – Over 400 suppliers. Nothing comes close

It's brash – If you're looking for comfortable affirmations of your chosen path, look elsewhere. Prepare for the clash of competing business models, technology predictions and high stakes bets

Whatever industry you're in, Internet World UK 2000 has dedicated content for you, whether you're in: Marketing, Retail, Manufacturing, IT & Internet, Finance

It's bright – The companies left standing when the dust clears will be the ones who got two things right: strategy and execution. Internet World's education programme helps on both fronts.

It's beyond – Today's solutions aren't enough. Internet World helps you look two steps ahead, on every front

According to a survey undertaken by Internet World UK 2000, 93% of e-movers and shakers don't think the Government is communicating effectively with British business on e-commerce.

Leading dot.coms have given a resounding 'thumbs down' to the British Government's recent record on UK.com at Internet World, Earls Court, London in May.

Tony Blair pledged last year to make the UK "the best place to trade electronically by 2002", but according to industry leaders in the new economy, only 7% of respondents think that the e-commerce minister, Patricia Hewitt, is doing an effective job.

The survey results make uncomfortable reading for anyone involved in the development of a potentially world-beating UK.com. Only 15% of respondents think that the UK government is helping the country to keep pace with the dynamic world of e-commerce.

Given the swiftness of the digital economy, any delay means that the UK is falling further and further behind the US and other 'e-savvy' nations each day. The concern of these business leaders is not that the Internet economy won't take off - it will - but that UK companies will be left behind and m never recover.

35% of respondents said that they thought Richard Branson would make a better e-envoy th the incumbent, Alex Allen. In fact, only one fifth those surveyed knew who the e-envoy was, whic is a worrying statistic given that Allen's primary role is to encourage British businesses to get online.

For further details, check: <www.internetworld.co.uk

Contact: Internet World, Tel: (0870) 7511 472.

Apple Previews QuickTime and Mac OS X at Developer Conference

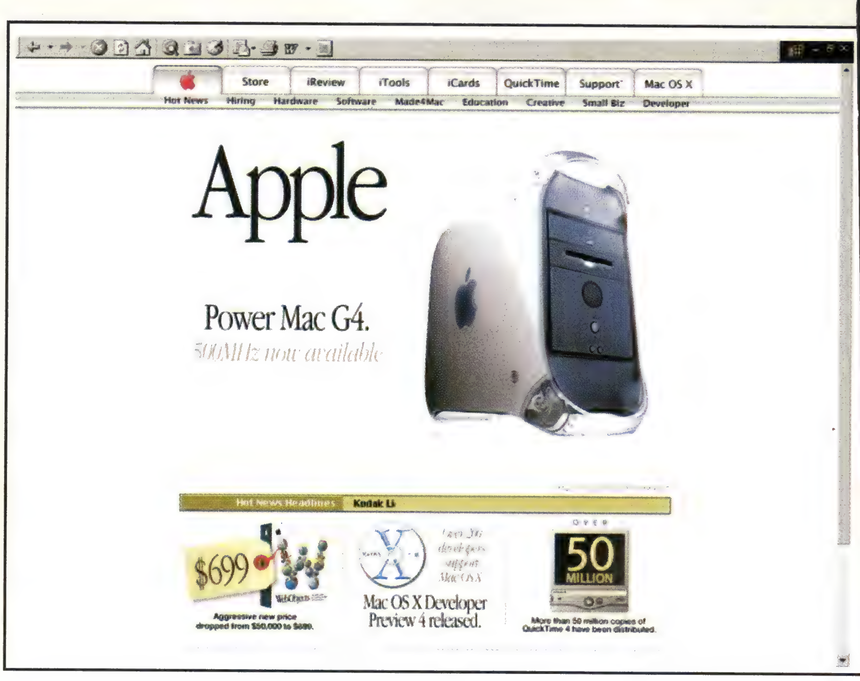
Apple gave developers at the Apple Worldwide Developers Conference in May a sneak preview c its next version of QuickTime.

Apple also released its fourth developer previe of Mac OS X to the 4,000 developers attending its annual Worldwide Developer Conference.

This preview version of Apple's next generation operating system includes the final API specifications required by developers to complete upgrades of their applications to take full advantage of Mac OS X's new capabilities. Mac OS X Developer Preview 4 also includes a version of Microsoft's Internet Explorer 5 specifically for Mac OS X, and support for the Java 2 Platform.

The new version of QuickTime, which will be available this summer and includes cross-platform support for MPEG-1 and MPEG-2, Flash 4 for Web animation, and an enhanced QuickTime VR playback function providing unlimited spherical views of virtual-reality scenes.

The new version of QuickTime will also feature QDesign software that has been optimised to take



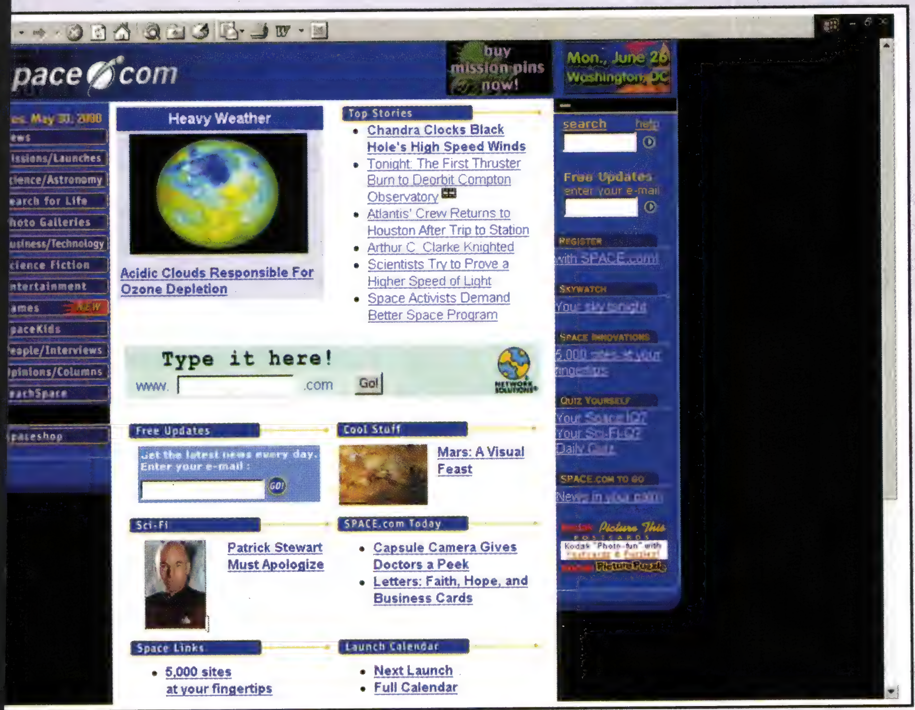
Power Mac G4.

500MHz now available

Aggressive new price dropped from $50,000 to $699.

Mac OS X Developer Preview 4 released.

More than 50 million copies of QuickTime 4 have been distributed.



vantage of the Power Mac G4's Velocity gine to encode music up to three times ter.

Apple's QuickTime 4 player for Macintosh d Windows users is available as a free wnload from ww.apple.com/quicktime>.

Mac OS X supports the Java 2 Platform, andard Edition (J2SE) featuring the otSpot client virtual machine. Mac OS X, a mpletely new implementation of the acintosh operating system, will be the only gh-volume personal computer operating stem with out-of-the-box Java 2 tegration. Java applications running on ac OS X will realise the benefits of the qua user interface, a major advancement in rsonal computer user interfaces.

A public beta of Mac OS X will be available is summer enabling customers to perience Apple's next generation erating system firsthand. The final version 0 of Mac OS X will be available in January 001. Mac OS X is designed to run on all acintosh computers using PowerPC G3 nd G4 processor chips, and requires a inimum of 64MB of memory.

For further details, check: ww.apple.com>.

Contact: Apple, Tel: (020) 8218 1000.

SPACE.com Chairman Keynotes at 37th Space Congress

SPACE.com Chairman and CEO Lou Dobbs delivered the keynote address at the 7th Space Congress on in May at Cape Canaveral, Florida.

"Space is the biggest story of our age and one of the largest emerging markets of our ime, offering unlimited commercial opportunities, from satellite technology to pace tourism," said Dobbs.

"SPACE.com's primary mission is to popularise space, we are proud to support the aerospace business community and I'm delighted to have the opportunity to open the 37th Space Congress," added Dobbs.

SPACE.com at **<www.space.com>** is the definitive space site on the Web, offering the richest and most compelling content, featuring news, information, education, entertainment, science fiction and games.

For further details, check: **<www.space.com>**.

Contact: SPACE.com, Tel: +1 212 703 5800.

Electronic Communications Bill Receives Royal Assent

The Government's commitment to making the UK the best place in the world for e-commerce hobbled forward last month, when the Electronic Communications Bill received Royal Assent.

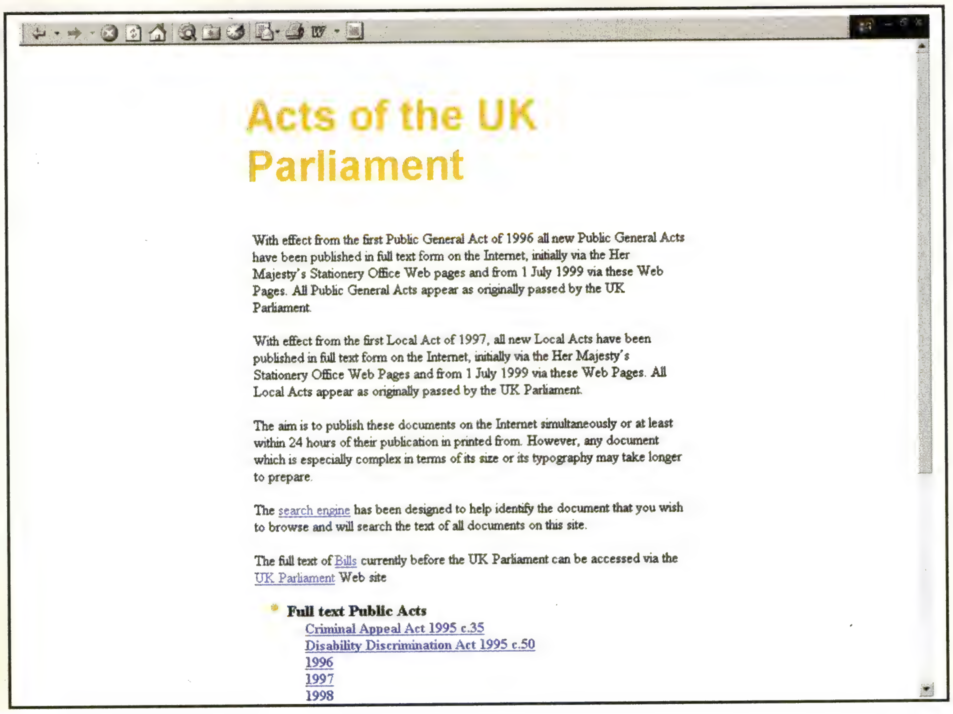
E-Minister, Patricia Hewitt said, "This Government is determined to make the UK the best place in the world for e-commerce. To realise this vision, we need a modern, flexible market framework, confident consumers and businesses, and a government that leads the way. The Electronic Communications Act is a significant step towards achieving all of these.

"This new legislation will create confidence in doing business electronically, giving legal certainty to electronic signatures and encouraging the development of secure and trusted e-commerce services. The Act gives us powers to sweep away obstacles in existing laws, which insist on the use of pen and paper, giving people the electronic option wherever possible. This will lead to major changes in the way Government delivers its services to citizens and businesses," added Hewitt.

Cabinet Office Minister, Ian McCartney said, "The Electronic Communications Act is a fundamental element of the Modernising Government programme. We have already launched initiatives to make the UK a world leader in e-commerce and to make information technology available to all. This Act is an important instrument for progress towards the target of making all Government's services available electronically by 2005, ensuring that we play a full part in the digital revolution."

For further details, check: **<www.uklegislation.hmso.gov.uk/acts.htm>** or **<www.dit.gov.uk>**.

Contact: DTI, Tel: (020) 7215 5000.



Acts of the UK Parliament

With effect from the first Public General Act of 1996 all new Public General Acts have been published in full text form on the Internet, initially via the Her Majesty's Stationery Office Web pages and from 1 July 1999 via these Web Pages. All Public General Acts appear as originally passed by the UK Parliament.

With effect from the first Local Act of 1997, all new Local Acts have been published in full text form on the Internet, initially via the Her Majesty's Stationery Office Web Pages and from 1 July 1999 via these Web Pages. All Local Acts appear as originally passed by the UK Parliament.

The aim is to publish these documents on the Internet simultaneously or at least within 24 hours of their publication in printed from. However, any document which is especially complex in terms of its size or its typography may take longer to prepare.

The search engine has been designed to help identify the document that you wish to browse and will search the text of all documents on this site.

The full text of Bills currently before the UK Parliament can be accessed via the UK Parliament Web site

- **Full text Public Acts**
  Criminal Appeal Act 1995 c.35
  Disability Discrimination Act 1995 c.50
  1996
  1997
  1998

Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

PROJECT RATING 1 Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering, side cutters, pliers, wire strippers, and screwdriver). Test gear not required and no setting-up needed.

PROJECT RATING 2 Easy to build, but not suitable for absolute beginners. Some test gear (e.g. multimeter) may be required, and may also need setting-up or testing.

PROJECT RATING 3 Average. Some skill in construction or more extensive setting-up required.

PROJECT RATING 4 Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.

PROJECT RATING 5 Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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Kits, components and products stocked at Maplin can be easily obtained in a number of ways:
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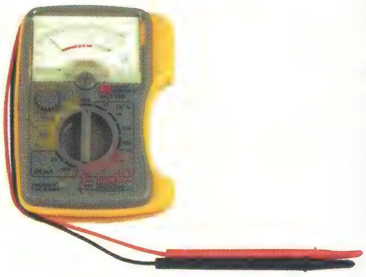

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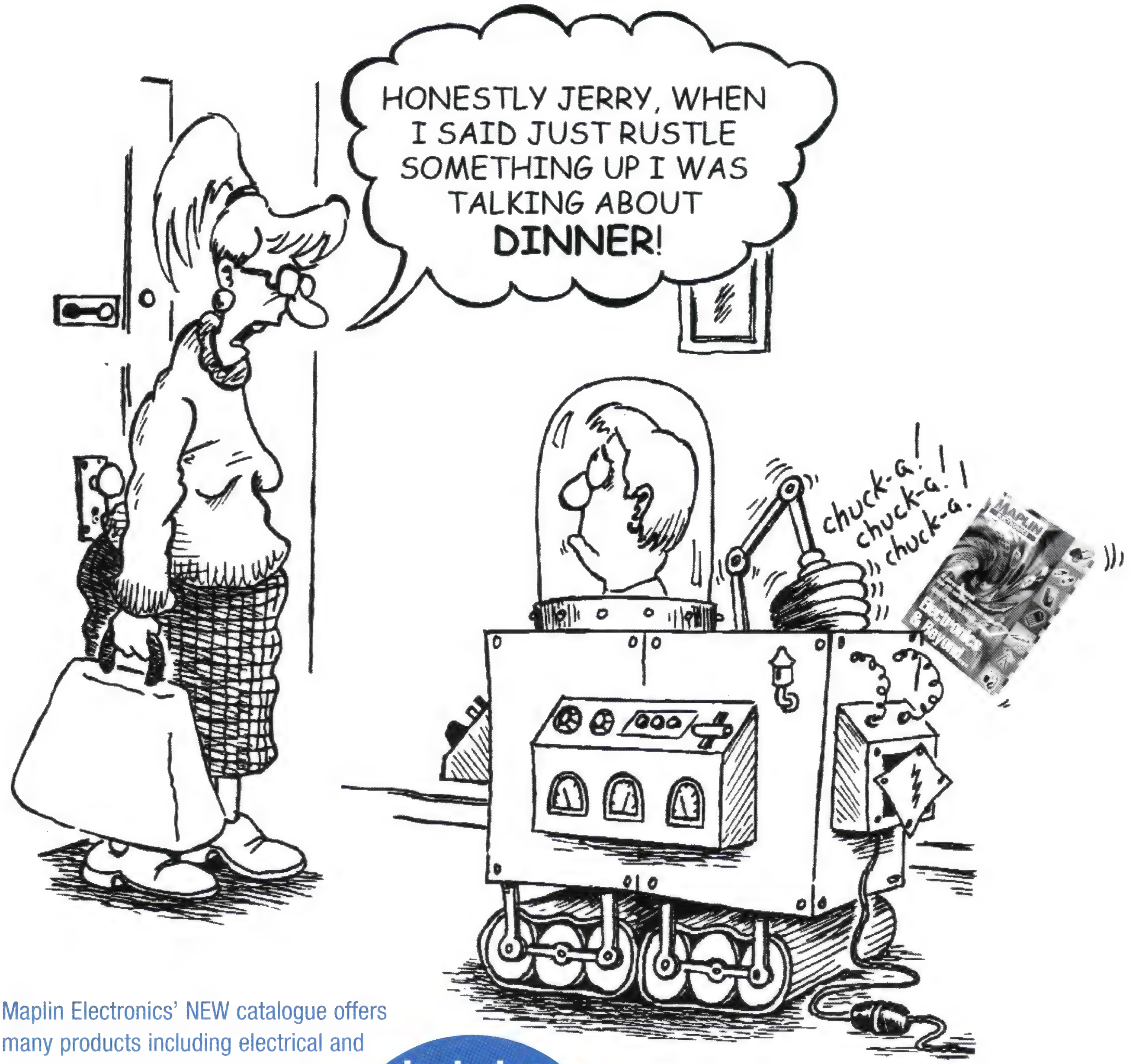
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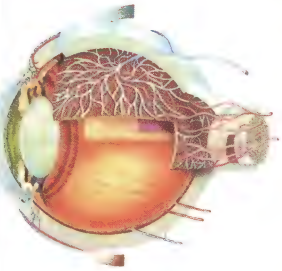

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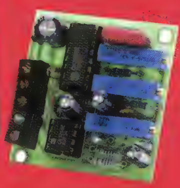

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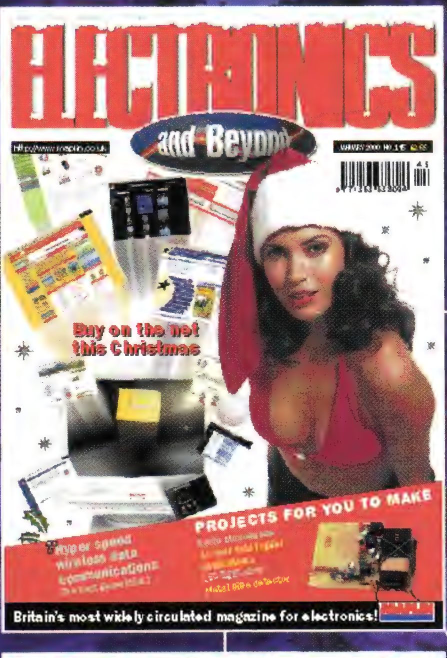
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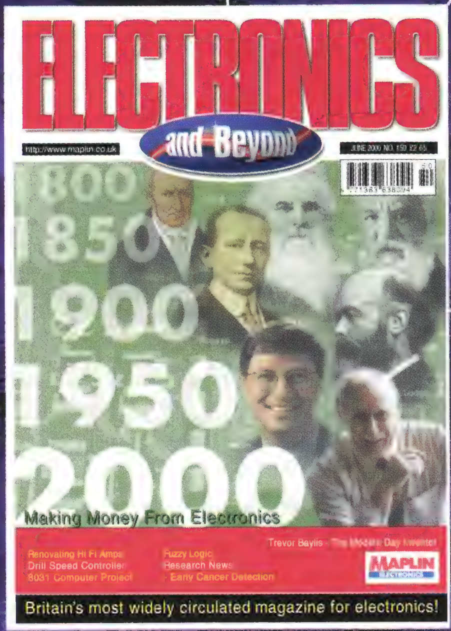

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FEATURES Fuzzy Logic
★ Very Low Frequency Waves Part 2
★ Trevor Baylis - The Modern Day Inventor

Issue 151 • Order as XD51F

PROJECTS Velleman AC/DC Converter
★8031 Single Board Computer Part 3
FEATURES
★ Liquid Crystal Displays
★ Speech Processing
★Rammed Earth Building Technology

Issue 152 • Order as XD52G

PROJECTS PC Controlled Disco Lights
★Digital Panel Meter
★General Purpose Portable Alarm
FEATURES
★ The Artificial Brain
★Beyond the Silicon Microprocessor

THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

eptember 2000 Vol. 19 No. 153

Projects

14 Microprocessor Temperature Controller
John Mosely evaluates the Velleman Temperature Controller and Sensor.

29 Telephone Alert
Gavin Cheeseman describes a versatile 'add-on' to your telephone that lets you know the telephone is ringing when you're in the garden.

Features

7 Uri Geller Extended Reality
Uri looks at the work that has been done in the past and present into telepathic communications between twins.

8 Wearable Computers
Not science fiction but reality, Reg Miles describes developments in this fascinating field.

13 Making Good Use of Waste Heat
Paul Freeman-Sear looks at how waste heat from generated electrical power can be put to good use.

17 Laser Battlefield of the Future
Douglas Clarkson reports on the eye damage that can result from current and future laser warfare.

21 Research News
Dr Chris Lavers reports on NASA's remote sensing contribution to medical sensing and the chemical sensing environment and an optical DNA analysis biochip reader for GP desktop medical applications.

24 Intelligent Machines
In this article David Clark examines how biomimetics and artificial intelligence are being used to make intelligent machines and systems.

42 The Very Long Waves
In this final part, George Pickworth explores high frequency alternators and submarine antennas.

49 Fuel Cell Developments
Reg Miles looks at how the desire for zero and ultra low emission vehicles is spurring on the development of fuel cells.

54 Evolvable Circuits
This month Mike Bedford examines the 'Genetic Algorithm', a phrase well known in software engineering - but what does it mean?

61 SCR Principles and Circuits.
Ray Marston describes basic SCR principles and provides practical SCR circuits in this special feature article.

Regulars

2 News Report
33 @ Internet
41 Comment
66 What's On & Diary Dates
68 Software Hints & Tips
69 Technology Watch
72 In The Pipeline
IBC Subscribers' Offers

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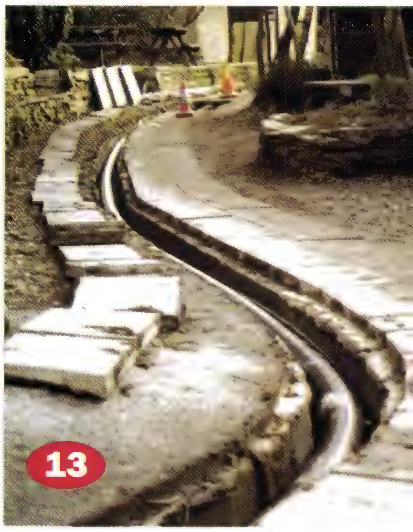
14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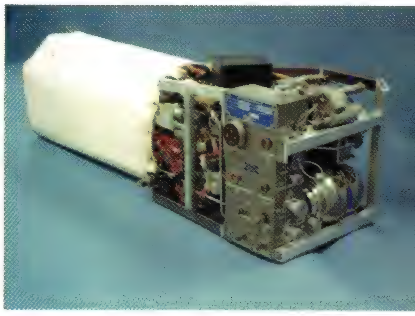

49

8

ELECTRONICS and Beyond

Wearable computers exist both in reality and in science fiction. Many science fiction films have tantalisingly implied the possibility of wearable computers, but now the development of such 'apparel' is now at the point where profit, actual or potential, is becoming the driving force. Increasingly, roles are being found for such equipment and the consumer market beckons enticingly in the distance. You can read more about this intriguing subject in Reg Miles's article.

It was over 160 years ago that William Grove discovered the fuel cell principle, but it is only in recent years that the concept of such energy sources has been exploited.

Development is now accelerating rapidly, due mainly to the impetus in the USA for zero emission and ultra low emission vehicles (ZEV and ULEV) and, at the other end of the scale, the many portable products using small batteries - mobile phones, camcorders, PDAs notebook computers, etc. Reg Miles describes the principle of various fuel cells in the second of his articles.

These are just two of the fascinating articles we have put together for you this month, so read on and, hopefully, enjoy.

New Uxbridge Store

Maplin has opened a new catalogue store in Uxbridge at 148-154 High Street (off Belmont Road). The store is open seven days a week (except Christmas), and offers some special bargains.

ELECTRONICS
and Beyond
News Report
Active colour display from a printer
Laser Battlefield of the future
Will our eyes be protected?
Wearable Computers
Not science fiction, but reality
Fuel Cell Developments
The desire for zero and ultra low emission vehicles
PROJECTS
MAPLIN ELECTRONICS
Britain's most widely circulated magazine for electronics!

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

CSR Announces Bluetooth Partnership

Cambridge Silicon Radio (CSR) has won a major order from ALPS Electric, a high-volume manufacturer of a wide range of electronic parts, for its BlueCore single-chip Bluetooth solution, which the Japanese manufacturer has chosen as the basis for its Bluetooth module.

CSR and ALPS are also collaborating on producing reference software stacks and software applications for Bluetooth.

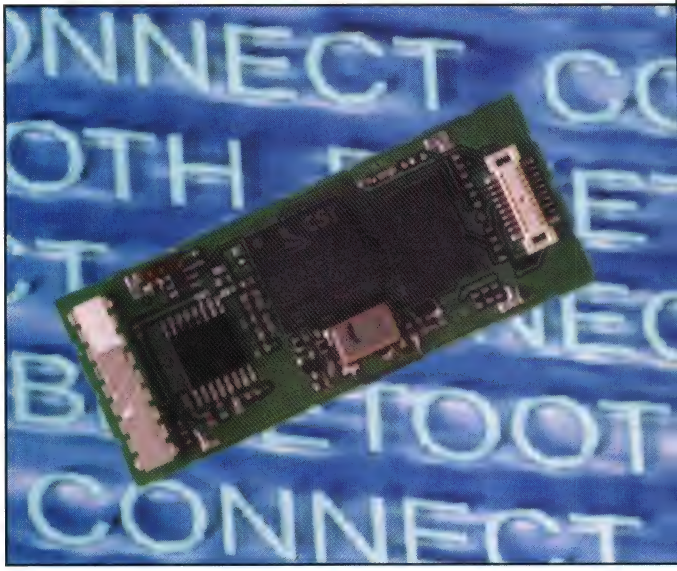
The new Class 1 module from ALPS is smaller than comparable products on the market at the moment. It includes an integral antenna, and therefore can be fully pre-certified to the Bluetooth standard, significantly decreasing the time to market.

CSR was the first company offer a fully integrated 2.4GH radio, baseband and microcontroller Bluetooth solution on one CMOS chip, with its BlueCore01.

CSR's BlueCore01 is the world's first true single chip Bluetooth system. Together with the Flash ROM containin the CSR Bluetooth software stack, it provides a fully compliant Bluetooth system f data and voice communicatio

Bluetooth is a worldwide technology standard that uses short-range, low-cost radio lin to connect multiple devices. For further details, check: `<www.cambridgesiliconradi com>`.

Contact: Cambridge Silicon Radio, Tel: (01223) 424167.



ujifilm Camera has)efinition for Large rints

The FinePix 1400 from Fujifilm has a Fujinon aspherical 3x optical zoom lens - the first of its kind for less than £300 - for razor sharp images. In addition, the camera has a conventional 1.3 million-sensor CCD that delivers a 30 x 960 resolution file that is large enough for colourful, picture- rfect 4 x 6 inch prints.

r further details, check: **<www.fujifilm.com>**.

ntact: Fujifilm, Tel: (020) 7586 5900.

ogica Shows Japanese lternative to WAP

gica has announced the global launch of m-WorldGate, the world's t commercially available cHTML gateway, based on a cut down rsion of HTML.

m-WorldGate will allow operators outside of Japan to either mplement their existing WAP strategies or to build new mobile ernet services based on cHTML.

m-WorldGate takes advantage of Logica's experience of the panese market to allow content to be presented on mobile phones pporting cHTML browsers regardless of the underlying network chnology.

Logica believes that the Japanese approach to the mobile Internet a proven business and technology model and that handsets pable of supporting an industry variant of cHTML on CDMA and SM/GPRS networks are expected to be commercially available at e end of this year.

Compact HMTL is a defined sub-set of HTML, the mark-up nguage of the Internet, and means that content providers can velop applications quickly and easily without having to learn new ethods of programming or relying on WML-based WAP converters.

r further details, check: **<www.logica.com>**.

ontact: Logica, Tel: (020) 7637 9111.

Mobile Phone Perils

If they're not dropped down toilets, munched by animals or had drinks spilt over them in pubs - one is stolen every three minutes. So with nearly half the UK's population owning one, it's no surprise that insurance claims relating to them are increasing all the time.

A survey by Mobile Phone Centre, operated by Vodafone, the 100-strong nationwide retailer, has found that accidents involving loos, beer and our four-legged friends are amongst the most common - jointly accounting for 21% of mobile phone insurance claims.

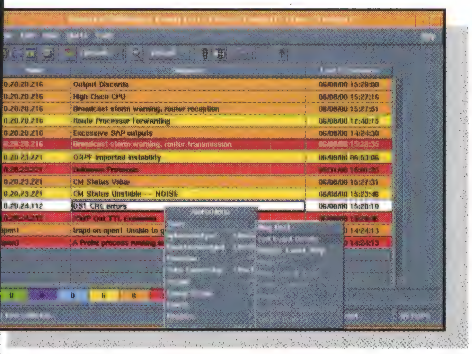
Although such incidents, which have included a phone being munched by a pig, another being buried in the back garden by a pet dog and even one falling from a bar into the slop tray, are amusing at first sight, people are left with the inconvenience of managing without a phone and the cost of its replacement, which can be 10 times the original price.

But it's not just the accidents that leave mobile phone users wishing they had insurance or thankful that they have. With mobile phones being stolen regularly, Mobile Phone Centre had 485 theft claims on its scheme in 1999 alone, which cost almost £70,000 and accounted for 51% of claims. In fact, around 15,000 mobile phones are stolen every month in Britain.

For further details, check: **<www.vodafone.co.uk>**.

Contact: Mobile Phone Centre, Tel: (020) 7709 9000.

licromuse Acquires NetOps



Micromuse is to acquire NetOps. NetOps produces a network problem diagnosis application called Visionary, which is compatible out of the box with Micromuse's Netcool family of realtime fault monitoring and service assurance applications.

By analysing management information from industry-standard Internet devices and applications, Visionary provides realtime, device-centric diagnoses that explain why a problem occurred in the network infrastructure, at the device level.

The Visionary technology also has the ability to predict - and therefore prevent - problems from occurring in the future, while providing significant savings on operational support.

For further details, check: **<www.micromuse.com>**.

Contact: Micromuse, Tel: (020) 8875 9500.

NEWS BYTES

Intel and Mitsubishi to Develop 3rd Generation Chipset

Intel and Mitsubishi are jointly developing a chipset for third-generation cellular phones. Mitsubishi hopes to increase its annual worldwide sales of cell phones from 25 million this year to 60 million in 2003.

For further details, check: **<www.intel.com>**.

Contact: Intel,
Tel: (01793) 403000.

Intel Publishes Chip Details

Intel has released technical details of its new Itanium microprocessor over the Internet, in a bid to boost the use of the Linux operating system with its chips.

Linux, an open-source operating system whose technical details are made freely available to software developers and engineers, is increasingly found on the servers that Intel hopes will soon be using its chips.

For further details, check: **<www.intel.com>**.

Contact: Intel,
Tel: (01793) 403000.

Cyber Security - Locking out the Hackers

iKey 1000 is an electronic key to protect computers from unauthorised access - has been developed by encryption specialists Rainbow Technologies.

iKey costs £29 and fits on a key-ring and slots into a desktop or laptop PC's universal serial bus (USB) port allowing authorised users easy access, but keeping others out.

The iKey is smartcard compatible, but since it uses USB technology is considerably cheaper to implement than the use of smartcard readers.

For further details, check: **<europe.rainbow.com>**.

Contact: Rainbow Technologies,
Tel: (01932) 579 200

NEWS BYTES

IBM Teraflop Supercomputer Chosen as Platform for Earth Simulator

The Potsdam Institute for Climate Impact Research (PIK), has selected a 200 Processor IBM RS/6000 SP system as its next generation supercomputer. This supercomputer will significantly enhance the capabilities of PIKs' researchers to assess mankind's impact on climate and other major components of the ecosphere.

The new system will be fifteen times more powerful than the preceding IBM machine operating at PIK since 1994 and it will rank among the 100 most powerful supercomputers in the world. Moreover, the system will be upgraded to teraflop performance in 2002 utilising IBM's ultra-fast Power4 multichip modules.

The SP system is based on the 64-bit, 375MHz POWER3-II microprocessor, a powerful copper chip developed for IBM's RS/6000 servers and workstations. The remarkable power of the POWER3-II microprocessor is derived from IBM pioneered copper wiring.

Copper increases microprocessor performance substantially compared with chips that use traditional aluminium.

The RS/6000 SP is a highly scaleable system made up of building blocks called nodes. An SP system can consist of just one or two nodes all the way up to hundreds of nodes. The system's performance scales almost linearly with its size. Each node contains one to sixteen microprocessors and its own random access memory (RAM) and disk storage.

For further details, check: `<www.rs6000.ibm.com>`.

Contact: IBM, Tel: (0990) 426426.

Iomega Demos Clik!-Enabled MP3 Player

Iomega has demonstrated the first Clik! portable digital media player. The RaveMP 2300 digital media player with a built-in Clik! drive gives music enthusiasts virtually unlimited, affordable access to their music libraries.

In addition to playing back digitally recorded music, the RaveMP 2300 records voice messages and allows users to download Microsoft Outlook names, phone numbers and e-mail addresses directly to Clik! disks.

The RaveMP 2300 features nearly 10 hours of continuous play with a single charge of the rechargeable lithium ion battery and incorporates skip-free sound with a built-in memory buffer, which is superior to current CD or Mini-Disc players.

For further details, check: `<www.iomega.com>`.

Contact: Iomega,
Tel: (01628) 828444.

Dell Shows Digital Audio Receiver

Dell this month showed its Digital Audio Receiver for the first time. The new appliance will enable listeners to enjoy CD-quality music stored on a PC in any room of the home by distributing audio to remote receivers or home stereo systems.

Powered by S3 Rio Audio technology, the Dell Digital Audio Receiver offers customers the ability to search, sort and play their entire PC music collection by artist, title, album, play list or genre. For further details, check: `<www.dell.com>`. Contact: Dell, Tel: (0870) 907 9078.

IBM Triples Capacity of World's Smallest Hard Drive

IBM has tripled the capacity - but not the size - of the world's smallest hard disk drive, paving the way for a new generation of 'go-anywhere' pervasive- computing devices and applications.

Packing a gigabyte (GB) of data storage capacity on to a disk the size a penny, IBM's newest Microdrive can hold up to 1,000 high-resolution photographs, a thousand 200-page novels or nearly 18 hours of high-qual digital audio music.

The 1GB Microdrive brings affordab high-capacity, high-performance data storage to a wide variety of handheld electronic products - including digital cameras, handheld PCs, personal digit assistants (PDAs), portable Internet music players and video cameras. It ca also serve as a data-exchange accessor to notebook computers, desktop computers and printers.

For further details, check: `<www.ibm.com>`.
Contact: IBM, Tel: (0990) 426426.

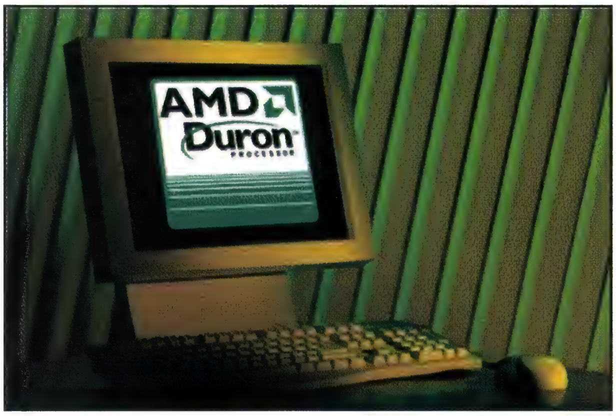
AMD Duron Processor Targets Consumer PCs

AMD Athlon PROCESSOR

AMD has introduced the AMD Duron processor, delivering industry-class performance for businesses and consumers in the value PC space, that typically sell for less than £600. The AMD Duron processor is available at speed grades of 700 MHz, 650 MHz, and 600 MHz.

The AMD Duron processor provides up to 25% more performance on many industry leading benchmarks than an Intel Celeron processor at the same clock speed.

Leading computer manufacturers worldwide have announced plans to offer AMD Duron processor-based systems, including Compaq, Fujitsu-Siemens, Hewlett-Packard Company, IBM and NEC.



The AMD Duron processor is a derivative of the award-winning AMD Athlon processor and is designed to provide an optimised solution for value conscious business and home users.

Employing an innovative design, the AMD Duron processor features a sophisticated cache architecture with 192kB of total on-chip cache; a high-spee 200MHz front-side bus, and a superscalar floating point unit with enhanced 3DNov technology.

For further details, check: `<www.amd.com`
Contact: AMD, Tel: +1 800 222 9323.

World's First Ink-Jet Printed Full Colour Plastic Display Developed

iko-Epson and Cambridge splay Technology (CDT) have veloped a 2.5-square-inch full lour display using CDT's light nitting polymer (LEP) chnology, an innovative splay science that paves the ay for the creation of ultra-nall, paper-thin consumer ectronic displays.

The prototype colour display as been made using CDT's d, green and blue polymer aterials and an industry-first k-jet printing process eveloped for the project. The olour display achieves colour quality equal to current liquid crystal display (LCD) technology and is comparable to displays found in many portable computer products.

This latest development follows an initial announcement in 1998 when CDT and Seiko-Epson demonstrated a monochrome plastic television display based on LEP technology and announced their intention to develop a colour LEP display.

The prototype colour display measures 2.5 square inches, has a resolution of 200 by 150 pixels, with 16 grey scaling at system level, and will be targeted at initial market entry points for LEP displays products such as mobile phones and personal digital assistants (PDAs). Beyond this, CDT and Seiko-Epson expect this technology eventually to penetrate all other display markets.

Based on an innovative manufacturing technique which uses ink-jet printing to deposit individual pixels made up of the red, green and blue LEP materials directly onto the substrate, potential display size is limited only by the size of the available wafer with no impact on the overall throughput when deployed in existing manufacturing lines.

The ink-jet technique allows the LEP material to be printed from a liquid solution and brings advantages when compared to existing and emerging display manufacturing processes by eliminating the need for backlights, colour filters and polarisers used in LCD displays and complex multi-shadowing techniques for depositing small molecules.

For futher details, check: **<www.cdtltd.co.uk>**.

Contact: CDT, Tel: (01223) 723555.

Ericsson is Absolutely Wireless

hree elements of the Ericsson Bluetooth ortfolio had their world premieres at CommunicAsia in Singapore this month: the first GPRS phone with Bluetooth - the triple band 520, the Bluetooth PC Card and the first luetooth mobile phone - the triple-band, WAP-nabled T36.

The R520 is the first step toward more advanced nobile Internet applications, featuring GPRS, High Speed Data (HSCSD), Bluetooth wireless echnology and WAP. Besides maximum speed evels the R520 also offers complete wireless connectivity with a built-in Bluetooth chip, removing requirements for cables between the phone and other mobile devices, such as PCs and handsfree devices.

The Bluetooth PC Card proves Ericsson's leading position in Bluetooth wireless technology. Ericsson also unveiled the T36 and the R520 mobile phones, which are the first phones to feature built-in Bluetooth communication. This means Ericsson is the first company to have a complete portfolio of voice and data products that use Bluetooth wireless technology.

The Ericsson T36 is the first mobile phone to have built-in Bluetooth wireless technology. Bluetooth makes it possible to connect the phone to other devices without using cables. It features WAP offering access to the Mobile Internet, and supports High Speed Data (HSCSD), making it capable of sending and receiving large amounts of data over the Internet at high speed. It is also the first triple band (GSM 900/1800/1900) phone from Ericsson, which means it can be used in Europe, Asia Pacific and America - in fact everywhere in the world where GSM frequency is prevalent.

For further details, check: **<www.ericsson.com>**.

Contact: Ericsson, Tel: (01628) 415500.

NEWS BYTES

Faster Lifecycles Create Headaches

The trend toward 'lifestyle' and designer products, the growing need to differentiate products and the acceleration of time-to-market competition is creating a new set of problems for computer vendors according to leading provider of inventory management services, PST.

PST believes that manufacturers are finding it harder to judge which products to manufacture and in what quantities and the result is that vendors are compelled to make compromises in production output.

Intense competition in the PC market - which is mirrored in all related component and peripheral markets - and the influence of on-line selling has forced vendors to reduce their time to market as much as possible.

In response, manufacturers are being forced either to produce very large quantities of very basic products that can be sold very cheaply, or use the most advanced technology and design to make the product more desirable. Typically, these products are produced in smaller numbers and sell at higher prices, but are still not guaranteed success.

For further details, check: **<www.pst.co.uk>**.

Contact: PST, Tel: (01628) 782233.

ARM Receives Deloitte & Touche Hot 100 Award

ARM has received a Hot 100 Award from Deloitte & Touche. The Hot 100 awards are presented annually by the professional services firm, to recognise and champion fast growing businesses in London and the UK.

The Hot 100 Awards focused on companies with turnovers of up to £100 million in their latest year that had achieved a significant year-on-year growth in their turnovers.

Companies were then ranked according to their average compound turnover growth rate over four financial years. ARM was ranked 11th, based on the company's results from 1994 to 1998.

Hot 100 companies achieved average compound growth rates ranging from between 18% and 95% over this four-year period and companies included in the ranking came from traditional as well as new economy sectors.

For further details, check: **<www.arm.com>**.

Contact: ARM,
Tel: (01223) 400400.

NEWS BYTES

MIT And Bell Labs Researchers Create Electronic Brain

Researchers at the Massachusetts Institute of Technology and Lucent Technologies' Bell Labs have created an electronic circuit that mimics the biological circuitry of the cerebral cortex, the brain's centre of intelligence.

The circuit is composed of artificial neurons that communicate with each other via artificial synapses. All of these elements are made from transistors fabricated on a silicon integrated circuit.

Like neurons in the cortex, nearby artificial neurons affect each other. There also is an inhibitory neuron that receives input from the 16 excitatory neurons and returns inhibition to them. This inhibitory feedback keeps in check excitatory feedback that can lead to explosive instability.

In the brain, synaptic feedback connections are thought to mediate neurons' cooperative and competitive interactions. Such interactions are expressed most strongly in the circuit when multiple stimuli are presented at the same time.

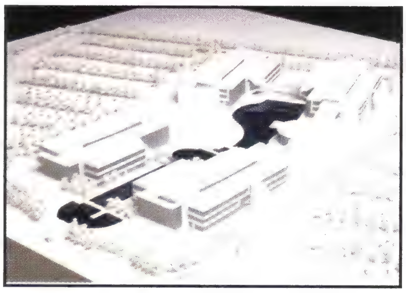
When simultaneous electrical currents are applied to two artificial neurons, the circuit responds to only one stimulus and suppresses its response to the other, much like a frog choosing which of two flies to strike at. Like the brain, there is no single element in the circuit that decides which stimulus to suppress. The decision is the outcome of an emergent, collective property of all the neurons.

A typical neuron in the brain might be connected to 10,000 other neurons. Because there are billions of neurons, this makes the brain a vast and intricate network.

For further details, check: **<www.mit.edu>**.

Contact: Massachusetts Institute of Technology, Tel: +1 617 253 1000.

Queen Opens Cadence Design Centre



Her Majesty The Queen officially opened Cadence Design Systems' Livingston Design Centre in Scotland in June.

The £20 million Livingston Design Centre (LDC) is the world's largest independent electronics design centre.

The LDC's focus is digital and analogue integrated-circuit and electronic systems design for wireless and datacom/telecom applications.

The LDC is located in The Alba Centre, the hub of a major Scottish initiative that is driving the future of electronics design. After deciding to build the centre in 1997, Cadence opened a temporary facility at Livingston.

The primary focus of Cadence and other organisations located at the Alba site is system-on-a-chip (SOC) design, which incorporates all of the components of an electronic system onto a single microchip.

For further details, check: **<www.cadence.com>**.
Contact: Cadence, Tel: (01344) 360333.

Intel Dot.Station Web Appliance Targeted at Service Providers

Intel has announced the Intel Dot.Station Web appliance, a communication product for the family that integrates access to the Internet, e-mail, a built-in telephone and home organisation applications.

Intel is in discussions with service providers worldwide to deliver the final product to consumers packaged with their services.

The Intel Dot.Station Web appliance also comes with the Intel System Management Suite, a unique capability that allows service providers to remotely manage and upgrade the new appliances as the Internet evolves. The Intel Dot.Station and the Intel System Management Suite form the foundation for Intel's complete Web appliance solution for service providers.

For consumers, the Intel Dot.Station Web appliance is an easy-to-use communication product that offers Web browsing, e-mail, a built-in telephone, and convenient home organisation features for the entire family.

For further details, check: **<www.intel.com>**.
Contact: Intel, Tel: (01793) 403000.

NASA Goes From Plants to Planets

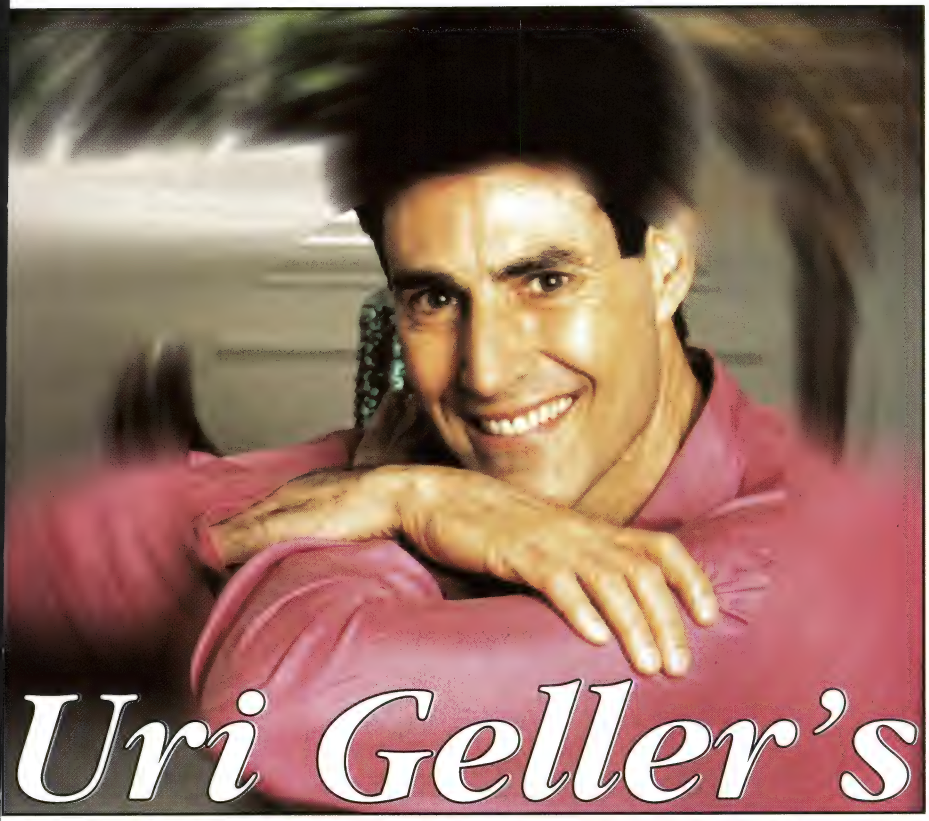
NASA scientists have gone back to the garden, planting wireless webs of small sensors in gardens here on Earth in preparation for missions to help monitor biological activity on planets.

Sensor webs like those being tested will help make possible a key NASA goal to establish a virtual presence for exploration throughout the solar system. Like satellites and telescopes remotely measuring planets across the vast reaches of space, the webs allow large areas to be monitored.

Unlike remote operations, sensor webs are placed inside the environment - thus making them capable of on-site detection not possible from afar. For example, satellite measurements cannot penetrate deep below the ocean surface or detect extremely small quantities of gases coming off a planetary surface.

The sensor webs could combine the spatial coverage of a satellite with the precision of an on-site instrument. Tests are now underway at Huntingdon Botanical Gardens, California.

For further details, check: **<www.nasa.gov>**.
Contact: NASA, Tel: +1 202 358 0000.



Uri Geller's

EXTENDED REALITY

Telepathy and Twins

As I mentioned in my July column, the first scientist to take a serious interest in twins was Sir Francis Galton. In an article first published in 1875, he noted that he had found " a similarity in the association of their ideas" in eleven out of the thirty-five twins he studied. He did not use the word telepathy, of course, because it hadn't been invented then (it was coined by Frederic Myers in 1882).

It was a very long time before anybody looked more thoroughly into the twin connection. Not until 1961, in fact, when a team of psychologists from Toronto published their report on it. They never actually got around to doing any experiments, but they did question a total of 35 twins, the same number as Galton studied, and came up with almost exactly the same percentage of those who had felt they had experienced some kind of telepathy with their brothers or sisters.

This is the kind of thing they reported: "Yes, I frequently know when there's something wrong." "Once when my sister cut her hand, I could feel the pain in my hand." "I can imagine what he's doing and see the place ... even if I've never been there."

The Toronto team took a closer look at the twins who had experienced this kind of thing, and found they had three things in common. Firstly, they were absolutely identical and had been brought up together, going to the same schools. Secondly, they were extraverts rather than introverts by nature, and finally they had no problem admitting the possibility of telepathy.

Again, it was to be a long time before anybody followed up their recommendations. In fact, as far as I have been able to discover, the first really large - scale survey of twin telepathy was not published until 1987, when a private researcher and mother of twins named Mary Rosambeau received six hundred replies after making an appeal in the national press.

Her questionnaire included all aspects of twinhood, and two of the questions she asked were if they had thought they had ever read their twin's mind, and if they had ever had the same pain or illness at the same time? A total of 187 said yes, they had almost exactly the same percentage as Galton and the Toronto team had reported.

Mary Rosambeau made an important discovery. Telepathy between identical twins, she found, always involved bad news an accident, illness or death. Or it could just be one twin "just knowing" that the other was in some kind of distress. She did not come across a single case of a twin picking up good news.

This probably explains why the few laboratory experiments that have been done have produced pretty unexciting results. The ideal experiment from the researcher's point of view (but not the subject's) would be to give one twin a whack on the head and see if the other reacted at a distance!

Actually, two experiments along these lines have been carried out, one of them in public, though without causing any harm to anybody. In 1975, a team of Spanish doctors and psychologists set up an experiment in the home of two four-year-old girls, which was disguised as a routine medical checkup. The father took one little girl to an upstairs room, where there was a camera running as there was in the downstairs room where the other twin, with her mother, was given a number of tests by the doctor in charge.

First, he tapped her on the knee to get a knee-jerk reflex. He got it, and so did the upstairs twin, who began to kick so wildly that her father had to hold her leg down! Then the downstairs one had a bright light shone into her eye. The upstairs one began to blink rapidly. Then she shook her head and held her nose her sister was being given a noseful of a strong scent.

As it happened, on the day of the researchers' visit, one of the girls had banged her head on a door, whereupon the other one burst into tears, which her sister did not. Their parents reported numerous similar incidents once, one of them was ten miles away with her grandparents when she burned her hand on a clothes iron, causing a large blister to appear. At exactly the same time a red spot of the same size appeared on her twin's hand in exactly the same place.

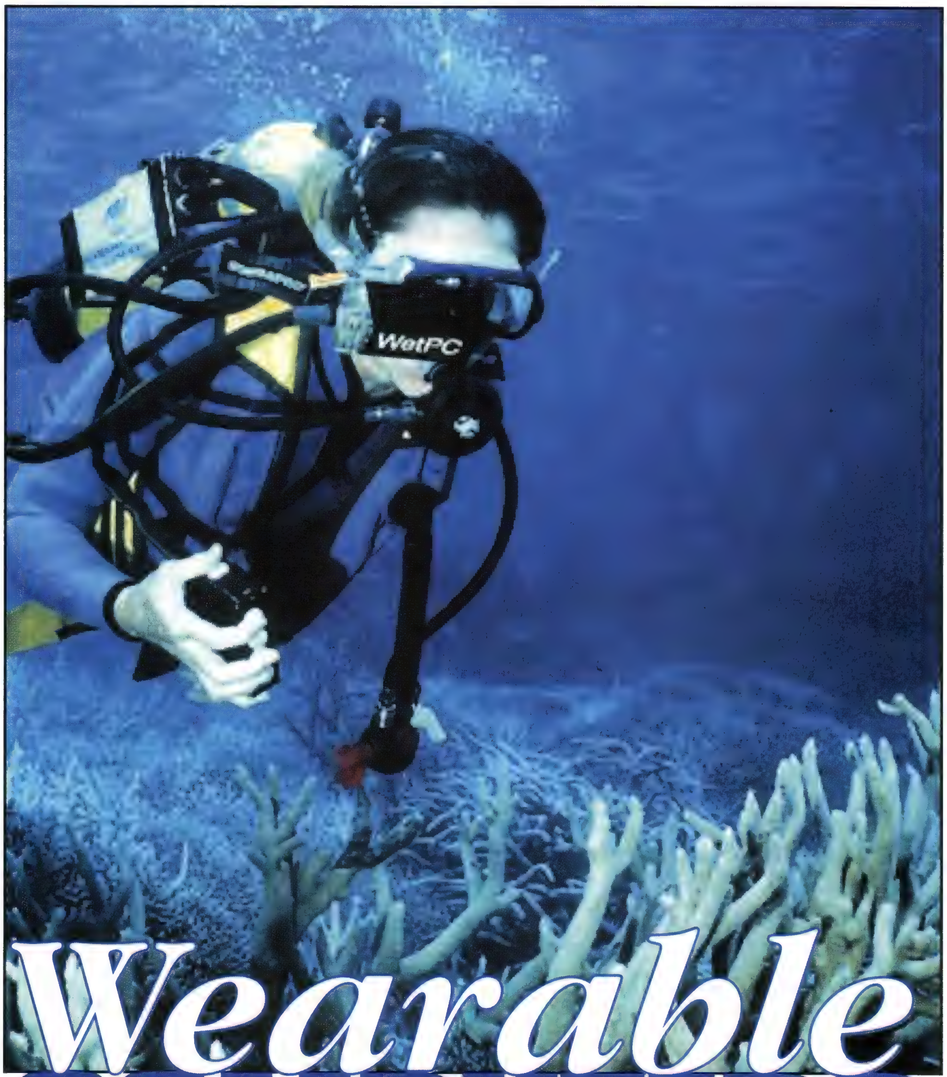
The second experiment was included in Paul McKenna's 1997 series of TV programmes on the paranormal. One twin sat in the studio in front of a large audience (and several million viewers) and was just told to relax and look at the large pyramid a few feet in front of her. As she did so, her sister was in another part of the building wired up to a polygraph and watched by a leading expert.

The chart showed a sudden peak at the very moment that the pyramid exploded in a cloud of coloured smoke. "Looks like a surprise," the expert commented.

I hope more experiments of this kind will be done to make clear what perhaps one third of identical twins already know: telepathy does happen, but only under certain conditions. I hope we don't have to wait another hundred years before everybody realises this.

Uri Geller's novelS *Dead Cold* and *Ella* are published by Headline at £5.99. *Mindmedicine* is published by Element at £20. Visit him at **www.uri-geller.com** and e-mail him at **urigeller@compuserve.com**

Uri Geller



Wearable COMPUTERS

Not science fiction but reality, Reg Miles describes developments in this fascinating field.

Wearable computers exist both in reality and in science fiction. The reality is that small bits of hardware are distributed about the person; the science fiction is everything integrated into clothing - initially the wiring, peripherals and connectors, eventually the computers themselves. Originally driven by geekish dreams, the development of wearable computers is now at the point where profit, actual or potential, is becoming the driving force as roles are being found for the equipment and the consumer market beckons enticingly in the distance.

The Need for Wearable Computers

Who needs to wear a computer? One answer is anyone who needs to operate one while doing other things. An engineer, for example, can be building or repairing something and have continuous access to relevant information - hands-free if a speech interface is used. Another answer is anyone who needs to constantly use a computer. A notebook computer has limitations in those circumstances. It cannot be used while walking, it can only be used inconveniently in a restaurant, and when you want to use it on the move you must set it down (probably get it out of a bag), open it up and switch it on. Notebooks were used as the basis for some of the earliest wearable computer designs. They still feature in many of the DIY efforts by those who do not possess the skills or have the inclination to build, test and modify their own computer (and when they are not on the move it can revert back to being a notebook). But they are basically two different concepts. The notebook is really no more than a conveniently small and portable version of a desktop computer that can be used in different locations, on any convenient surface including the lap. A wearable does not require a surface, nor is it restricted t usable locations; it is not just a tool but something of a state of mind - free and personal (no matter that such things are purely illusory), and an apparent extensio of the body.

Academic research is exploring these concepts as various forms of 'affective computing'. In these cases the computer worn and operational for most of a perso waking hours in order for them to effectively be a communications hub. The computer can act as an aide memoire throughout the day, recognise faces that they might have forgotten, provide navigation in unknown areas, and generall recognise what the user is doing and provide assistance in whatever way is appropriate.

In the rather more mundane world of th everyday present, two approaches have been adopted to facilitate wearable computing. One is the genuine article, where the user is able to operate individually with self-contained equipment The other is an intermediate stage in whic the user carries a basic 'client' that is linke to a central server - wirelessly or wired depending on the situation.

Network-Dependent Approach

This network-dependent approach is really only practical within a limited radius, as would be the case within the confines of a company. The application resources are on required by the server, rather than being distributed over all the clients; while any changes that are necessary to update, upgrade or reconfigure the system need only be implemented on the server. Which is ideal if all the clients are going to be use for the same purposes all the time and thu require only limited application resources.

An example of this approach is one provided by SyVox, with their SpeechNet system. This enables mobile workers in factories and warehouses to communicate with computers while keeping their hands and eyes free for their work (Figure 1a). Workers wear a small, wireless Speech Data Terminal (Figure 1b) which acts as a speech input/output device. In operation the worker communicates information and instructions to the SpeechNet Control Unit, this then exchanges information with an enterprise network - such as a warehouse management system - and transmits instructions back to the worker. Apparently, the system can be used in noisy environments (80-95dB) without errors; an is speaker independent so that it does not have to be trained to recognise any particular speaking voice. The system can also incorporate complementary data capture devices such as scanners, pens and keyboards to introduce greater flexibility.

Various experimental studies have been and are being done on the uses of audio in the workplace. The use of auditory cues to indicate the state of machinery within a factory, is a typical example. Distinctive sounds played simultaneously merge to allow workers to hear the factory both as a whole and as individual aspects such as the

ure 1a. SyVox SpeechNet System.

e and functioning of machinery. Any oblems in the running of machines could indicated by changes in the sounds and specific signals to indicate the type of oblem.

Similar techniques are being explored for anaging messages with the minimum of rsonal disruption. Thus a person ceiving a wirelessly communicated e-mail voice mail will be notified by a discreet dio cue, including an indication of its iority, rather than have it suddenly splayed or played. This could be either a ent in a local area network or a full earable computer.

The point about a wearable is that it has be worthwhile to actually wear it. If it was st a computer then its uses would be very mited as most people have no requirement r computing on the move (most people ave no requirement for computing at all, ut that is another matter). Computing has be just one of a number of facilities that ave different priorities at different times, ut that are thoroughly integrated, or there ever will be a market beyond the industrial nd military.

Vearable Computers

hat IBM has produced protoype wearables robably indicates that the situation is about

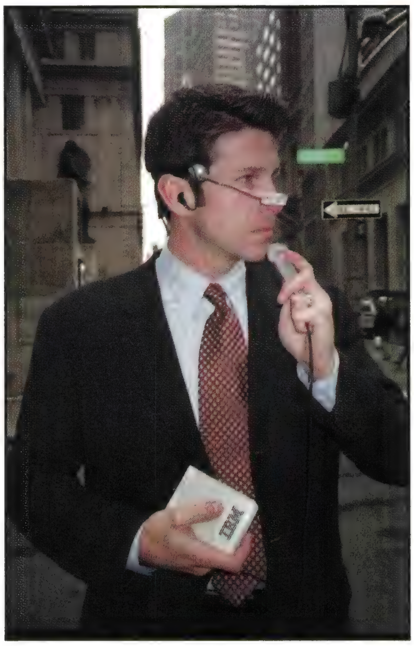


Figure 2. IBM prototype wearable computer.

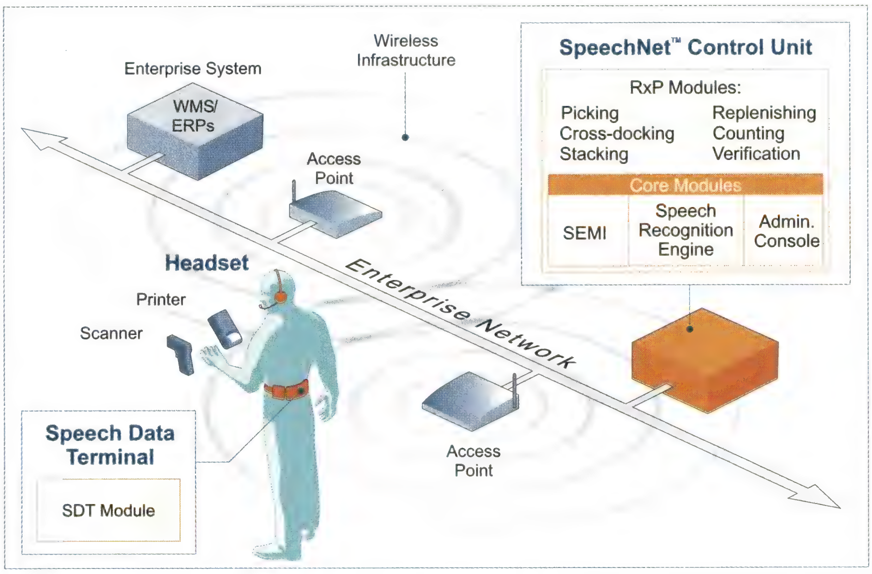


Figure 1b. Block diagram of SyVox SpeechNet System

to change and move to a more mainstream market. The latest is a 299g unit the size of a personal stereo, incorporating a 233MHz processor and an IBM microdrive, connected to a micro-display headset and a one-handed controller with microphone, tracker and click button - see Figure 2.

As yet there are not that many wearable computers actually being manufactured; and specialist companies such as ViA and Xybernaut are doing all the running. This limited production has inevitably meant that the prices are comparatively high, which has in consequence limited the demand and made any increase in production impractical. Just as a notebook is more expensive than a desktop for the same specifications, so a wearable is more expensive than a notebook. Prices begin at $2000+ for a basic system without accessories and go up to over three times that amount (the market is largely confined to the USA at present).

The wearable concept began with people making their own, and a lot of people are still doing so because of the high prices. One company, Circus Systems, is planning to launch a series of low cost kits to enable people to build their own wearable computer and accessories, in addition to launching ready-built products.

The processor speeds of commercial wearables varies between 133-266MHz. This will probably be one of the types intended for embedded applications, such as a PC/104 CPU module, the Cyrix MediaGX, Motorola's ColdFire or one of the Intel range such as the Pentium MMX or StrongARM. There are four reasons for such a choice: the first is that the processor and peripherals form a small, lightweight device with low power consumption. Figure 3a shows an arrangement of PC/104 modules - which can also be stacked, while Figure 3b shows the integrated ColdFire microprocessor. The second is that product development time is significantly reduced with these standardised products; the third is that they

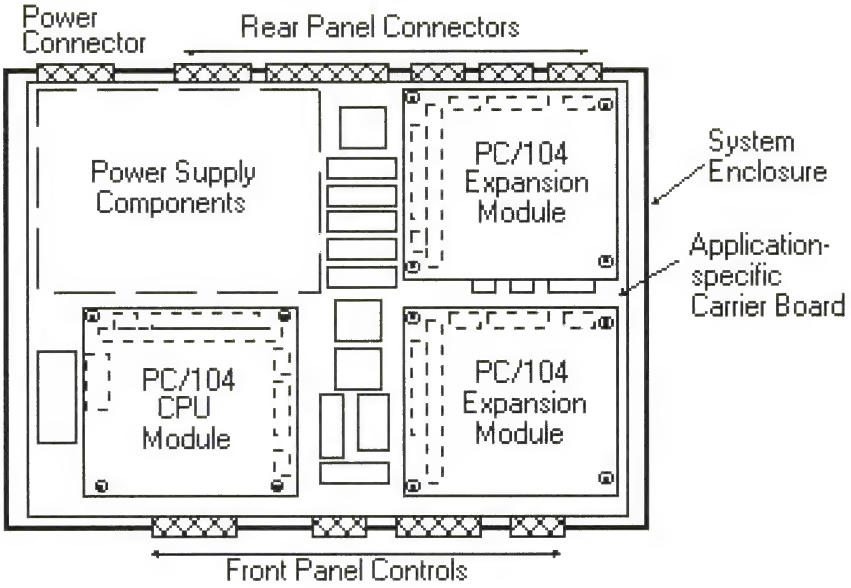


Figure 3a. Arrangement of PC/104 modules.

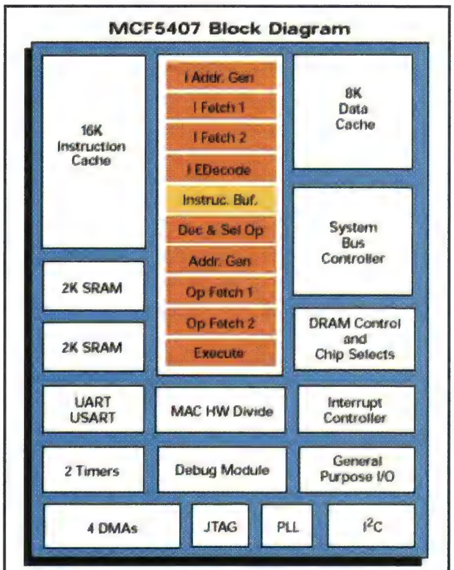


Figure 3b. Integrated ColdFire microprocessor.

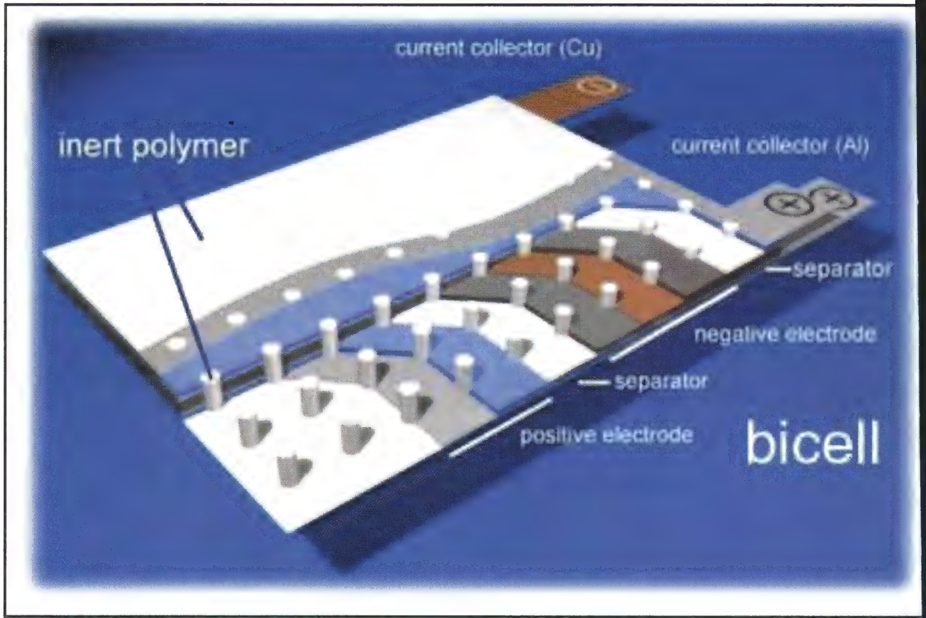


Figure 5. Philips Lithylene 'rivet technology' battery.

are more robust than a conventional computer design; and the fourth is that they are cheaper. Which is why they are also favoured by people making their own wearables.

In commercial wearables RAM generally begins at 32MB, with options up to 128MB. Obviously if speech recognition and synthesis are going to be used the more memory there is the better. Also, the greater the capacity of the hard disk the better. The range goes from over 1GB to over 4GB, so there should be no shortage of storage space. There will also be an optional external floppy disk drive. A range of ports and PCMCIA slots are provided, either directly or via adapters, for further storage. Any device that would be suitable for use with a notebook will be equally suitable for a wearable. Figure 4 shows the connectors on the ViA II model - it also shows the centrally hinged design that makes it possible to wear it lengthways on a belt instead of having it hanging down. Thus the user will have access to CD-ROM, CD-R and CD-RW; magneto optical, including MiniDisc; the high capacity floppy disk drives; Zip drive; small external hard drives; and various types of flash memory devices.

Other devices provide for wired or wireless LAN, modem, cellular phone, GPS, etc. - a wearable user need feel no sense of inferiority! The only considerations are the size, weight and power consumption.

Lithium-Ion Battery Supply

Everyone seems to favour the lithium-ion battery to provide the power. Which is not surprising, given that its price-performanc ratio is better than that of the alternative technologies - nickel metal hydride, nickel cadmium and lead acid; and that it is ideall suited to intensive use with a long runtime between charges (it is also maintenance-free). Because a wearable draws less powe than a notebook a fully charged battery wil last from two to three times as long. And the commercial models at least allow hot swapping. Alternative means of powering them are an AC adapter and a car adapter.

The lithium ion type is not perfect however, it is subject to ageing with a life expectancy of no more than a couple of years, and so should be used intensively from the beginning. Hence companies are working on a variation of the technology, known as lithium polymer. Philips is developing its LithyLene 'rivet technology' for licensing (see Figure 5): two single-side positive electrodes are placed on either sid of a double-sided negative electrode with a separator between; both electrodes have small (1mm) holes into which a heated polymer is forced, and once set hard this holds the active materials together and provides a stable battery structure without the need for a conventional metal can. The result is thin flat batteries with a higher energy density per volume. An American company called Electrofuel has a lithium polymer battery claimed to give up to sixteen hours of notebook use in a 1kg titanium pack measuring 223 x 300 x 9.5mm.

Looking further into the future, Xybernaut and DCH Technology have begu co-operating on a project to develop a wearable that will run on hydrogen fuel cells. DCHT specialises in hydrogen technology and is developing a proton exchange membrane, also known as polymer electrolyte membrane, (PEM) cell licensed from Los Alamos National Laboratory. Hydrogen is supplied to the anode where a platinum catalyst separates it into protons (hydrogen ions) and electrons - see Figure 6. The electrode conducts protons but not electrons, so while the protons pass through the central membrane

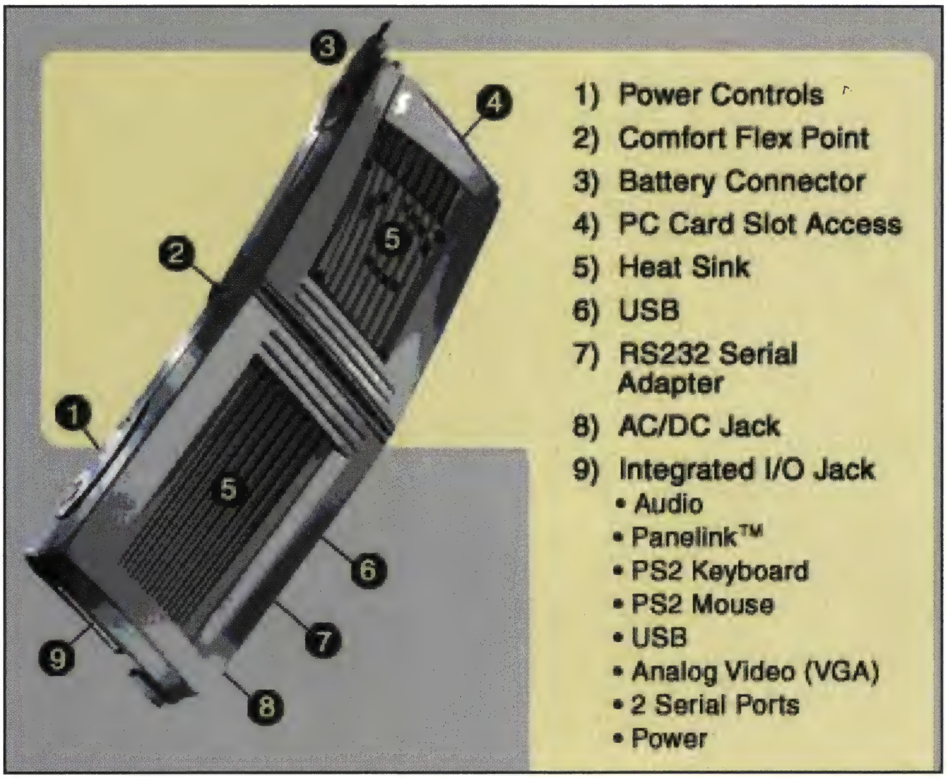


Figure 4. ViA II connectors

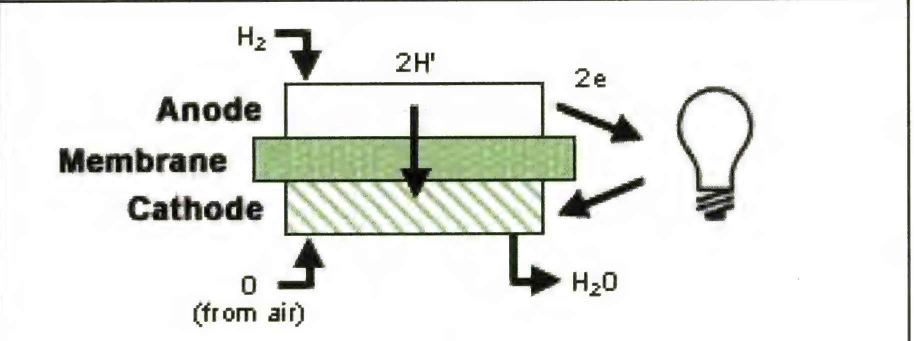
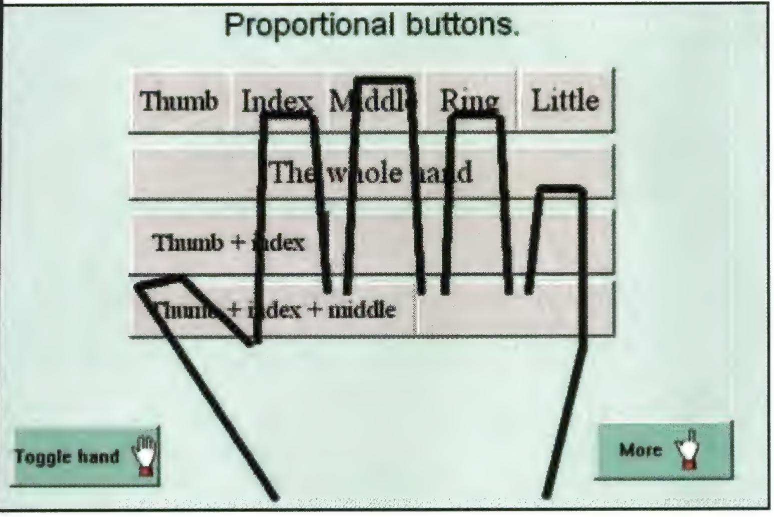


Figure 6. **Polymer electrolyte membrane battery.**



gure 7. **5-button Kord pad.**

e electrons must travel through the xternal circuit and thus provide electrical ower. Another platinum catalyst then ecombines the protons and electrons, and dds oxygen from the air to produce water r the humidification necessary for the assage of the protons. The hydrogen can e supplied from a metal hydride or from a ydrogen rich fuel such as methanol.

The alternative approach to increasing perational times is to reduce the power onsumption through components that raw less power and through more ntensive power management.

A related area of research is concerned vith reducing the waste heat of power onsumption. The large heatsinks shown in igure 4 clearly illustrate the intrinsic roblem of dissipating the heat generated y components packed closely together in a ecessarily small case. The obvious way of lealing with it is to have components that equire less power to operate, and that nake more effective use of the power - not vasting it as it travels around the chips. But hat is the province of the chip manufacturers. Part of the additional cost of wearables is pent on achieving designs that compensate or what the chip manufacturers have not et achieved. Active cooling using a fan bviously consumes battery power, and equires a larger case. Passive cooling may not always be sufficient. One aid to passive cooling that is being tried is embedding the components in a polymer to facilitate conduction. Another is to use a phase change material within the casing that will melt at a certain temperature and also facilitate conduction (this can be combined with the former) - but cooling is not a problem confined to wearables.

Of course, fuel cells and battery technologies are not being developed exclusively for wearable computers. In fact much of what I have described thus far could equally well apply to a small notebook - there is also the same choice of operating systems, with commercial wearables normally having one of the MS Windows systems installed while the DIY people tend to favour Linux. Where the difference does become noticeable is in the input and output devices that are required to make the concept practical.

Chordic Keyboard

One such device is the chordic keyboard. This takes its name from the fact that combinations of keys are pressed for entry just like playing musical chords. There can be as few as five keys - four fingers and thumb - to enter letters, numbers, words, commands or other strings. The most popular chordic product is the Twiddler, made by Handkey: a one-handed device with twelve finger and six thumb keys that give over four thousand combinations, plus an integral pointing device that operates by tilting the Twiddler. A new alternative to this is the Kord pad, a five button keyboard that has been designed by the Australian Institute of Marine Science, originally for use by divers with the Institute's WetPC. It is the first chordic keyboard to have an on-screen GUI display that shows which fingers must be used to press the keys for particular tasks, obviating the need to memorise them - see Figure 7.

The WetPC, incidentally, is based on a PC/104 embedded processor. It is connected by a cable to a mask-mounted scanning display and by another cable to the chest-mounted Kord pad (Figure 8 shows the placement and the computer).

Other types of keyboard are available for wearables use - small QWERTY arm mounted ones and even smaller wrist mounted ones. There are also small pen pads. It is also possible to use the finger as a pointing device, either directly on a touch-sensitive screen, or indirectly, in combination with a head-mounted camera and tracking software. In the latter, an image is superimposed onto a head-up display (the finger's movements being recorded by the camera, tracked by the software, and displayed on the virtual screen as an active pointer).

Head-Up Displays

There are a number of head-up displays available. Most of them employ tiny active matrix LCD screens of less than 1in, with

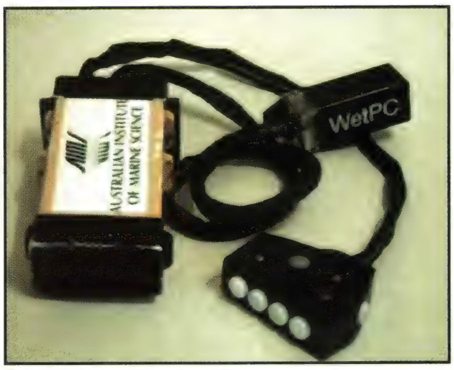


Figure 8b. **The WetPC arrangement.**

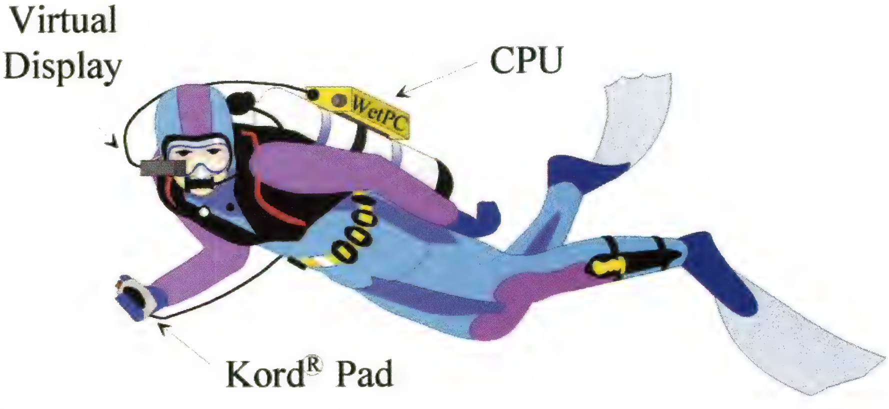


Figure 8a. **The WetPC arrangement**

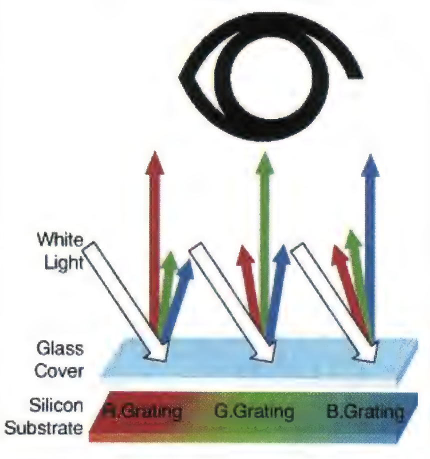


Figure 9. MicroDisplay system.

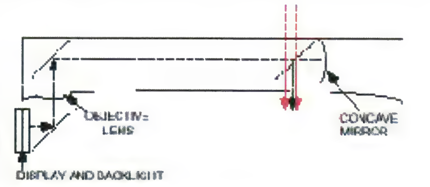


Figure 10a. MicroOptical Corp. microelectromechanical system

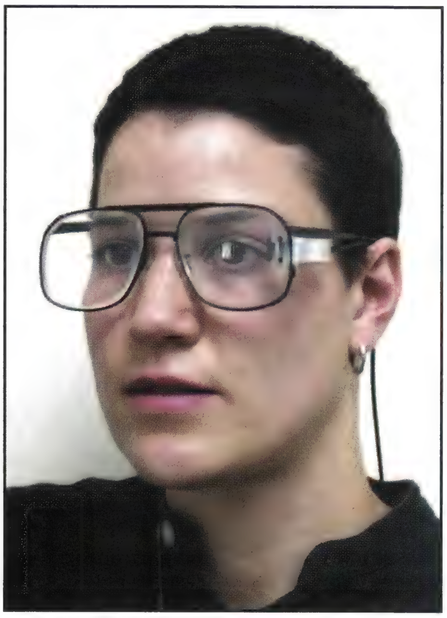


Figure 10b. MicroOptical Corp. glasses

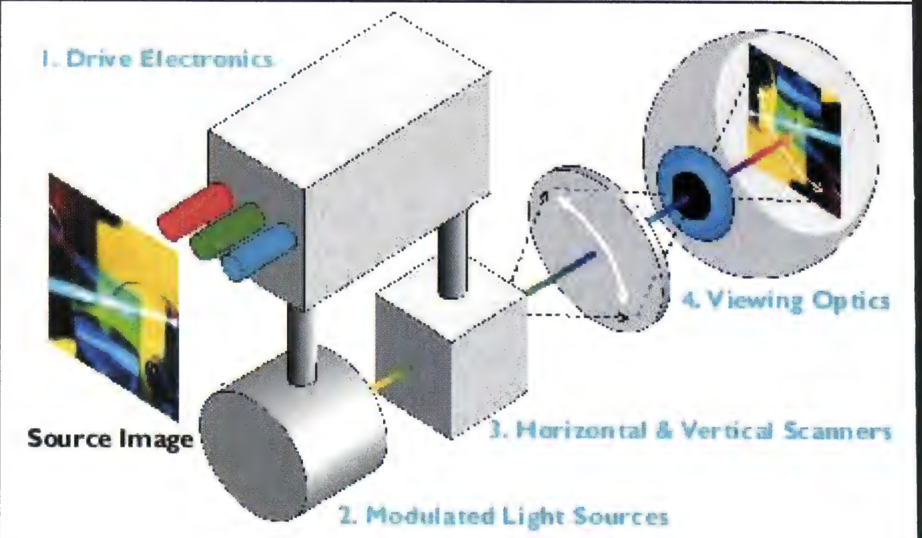


Figure 11. Microvision retinal scanning display (RSD).

magnifying optics to produce a larger virtual image. Other technologies with equally small screens are being used or tried out: variations on LCD, such as ferroelectric liquid crystal (FLC) and dynamic nematic liquid crystal on silicon (DNLCOS); and

emissive technologies, such as electroluminescent (EL), active matrix electroluminscent (AMEL), field emissive display (FED), LED, organic LED (OLED) and active matrix organic LED (AMOLED).

The resolution may be 640 x 480 VGA, or 320 x 240 quarter VGA, some achieve 800 x 600 SVGA, and a few manage even higher resolutions. But being small makes the image look better than the figures suggest. The sequential displays will also look better than the filtered ones. The former run at approximately three times the normal refresh rate to show alternate red, green and blue images synchronised to light from appropriately coloured LEDs. Note that all the pixels are used all the time, whereas the filtered display has a mosaic of RGB filters, effectively reducing the resolution - and the brightness.

One alternative to this is under development by MicroDisplay. Here filters are replaced with diffraction gratings, produced at no extra cost on the silicon backplane during fabrication; three differently spaced gratings per pixel give red, green and blue light under white light illumination - see Figure 9.

Head-up displays also come in two types - closed and open. The former is like an electronic viewfinder, you look into it with one eye and keep the other open. The latter is transparent, so that you look through what appears to be a large display suspended in space some distance in front of your face. Generally, the displays are monocular, unlike the virtual reality displays - although these can be used as well.

There are also displays that can be attached to glasses. The AlbaTech Personal Monitor clips onto the bridge and projects a single LCD image into both retinae via dividing mirrors. The effect is apparently one of viewing a 26in display suspended two metres away in the centre of vision, with the environment visible all around.

Monocular Displays

MicroOptical Corp. takes a slightly different approach. They have a monocular display that attaches to the side of the glasses. The company is also developing integrated displays. Here, the image is reflected and magnified within the eyeglass lens by an embedded optical relay (Figure 10a - Figure 10b shows the glasses). The advantage of this approach is that when the display is off the user can see normally because the reflector is translucent, and normal prescription lenses can be fitted.

MicroOptical is also working on microelectromechanical systems (MEMS) for scanning images, but information was not forthcoming. But another company, Microvision, seems to be further advanced, or is just less reticent about MEMS for imaging. Their retinal scanning display (RSD) employs a mirror of less than one square millimetre, this scans in both horizontal and vertical directions projecting a flying spot of light from LEDs onto the retina in a raster pattern - see Figure 11. This is state-of-the-art stuff, but for those who do not require a head-up display there are plenty of small LCD panels available, including ones that can be wrist mounted.

Even more state of the art is computers built into clothing. Conductive fibres can be woven into materials, and conductive inks can be printed onto fabrics. People are already walking around with wearable systems integrated into their normal clothing and accessories, including microswitches as one means of keying in data, a fabric antenna, and such like. Philips in Redhill has a current project aimed at using electronics to enhance clothing; not wearable computing, but their sensor jacket gives a good indication of what can be done - see Figure 12.

If you fancy buying a wearable system, or constructing one, or are merely interested, then a good place to start looking is Wearables Central (`http://eyetap.org/wearable/`). The site has information, and links that will lead you directly or indirectly to all the other relevant sites - new ones appeared even as I was working on this article, so it is certainly taking off and we can expect to see some big changes in computing on the move in the near future.

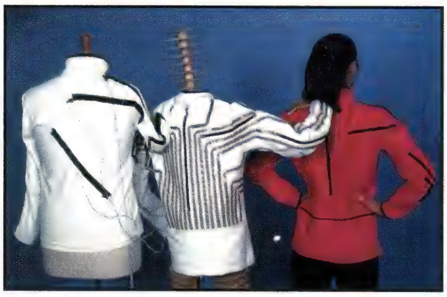


Figure 12. Philips sensor jacket

Making good use of
WASTE HEAT

Heat Main being installed at CAT

What do you do with all the waste heat that is created from our electrical power stations? Even now the majority of that heat is sent into the atmosphere via cooling towers or discharged at sea or into our rivers. Power stations are quite frequently away from urban centres and therefore it has been argued, would be uneconomic to transport heat over long distances. There was one notable exception in the past and that was Battersea Power station in London where the waste heat was distributed around the surrounding estates.

'Greener' attitudes have brought into focus the nonsense of wasting this heat and that it could be used in a better way. Governmental changes more recently now means that virtually anyone can generate their own electricity, be they a commercial concern or individuals and that liberalisation will bring electrical generation back into urban centres. The other added benefit to this is, with approval, surplus electricity can be exported into the national grid network. One method of generating electricity on a small to medium scale is Combined Heat and Power.

CHP

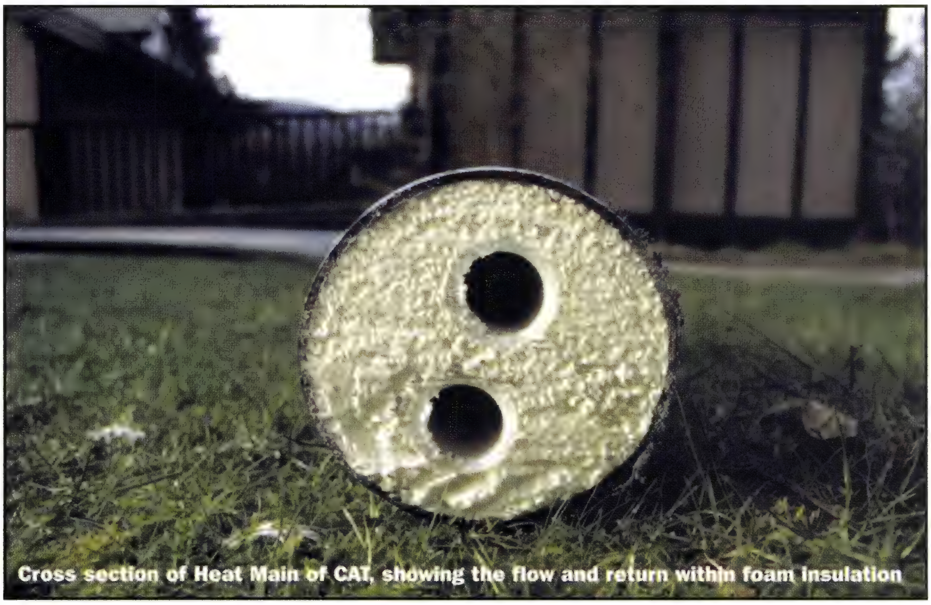
Combined heat and power systems make good use of the by-product heat that is generated as a result of generating electrical power by conventional means ie heat energy usually in the form of a hot gas produces rotational energy. In a Combined Heat and Power unit that heat is typically used for keeping buildings warm or for example in a chemical plant, heat might be required for increasing the speed of chemical reaction. There are now a growing number of installed CHP units in the UK generating around 4GW at present and a governmental directive has said that CHP output should increase to 10GW by 2010. These small power plants might typically appear on waste reclamation sites, leisure centres and now more recently on large industrial works.

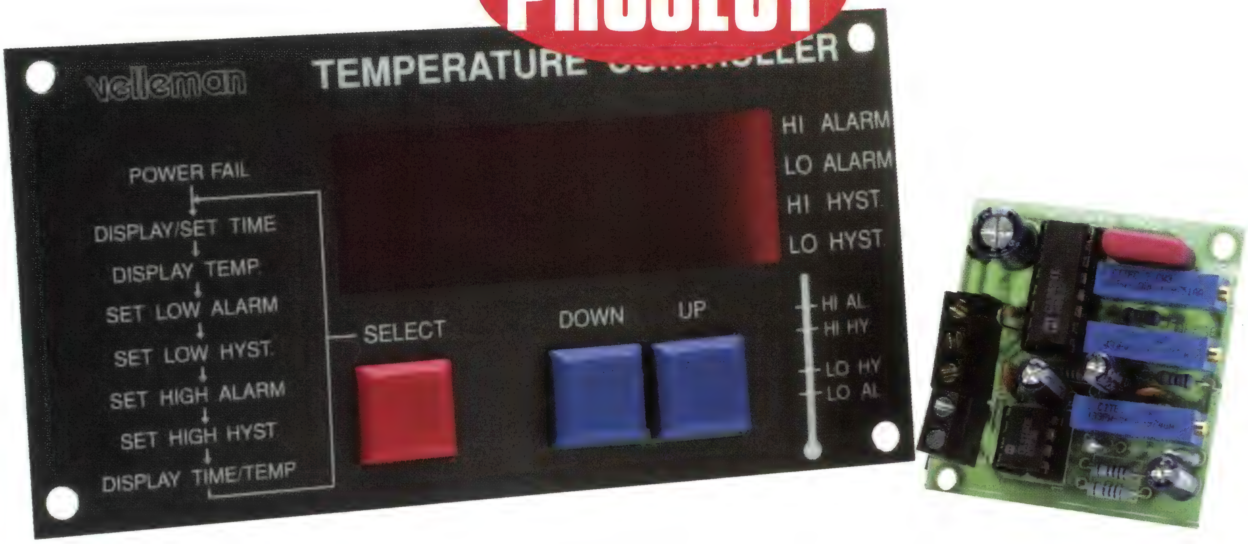
District Heat Main at CAT

The Centre for Alternative Technology in Wales has installed a heat main. This is where heat can be 'traded' across the site from a variety of sources. The sources in this case are a resident wood chip boiler and the solar water heating system. The wood chip boiler runs from waste wood chip from local forestry plantations. The new solar water heating panels installed on the new information centre has an area of 120m^2 and these panels feed solar heat into the heat main. The heat main consists of two 40mm plastic flow and return pipes encapsulated in foam insulation with a butyl outer plastic casing. This heat grid links to seven major buildings on the site and will provide plenty of hot water for the buildings. The design will aim to demonstrate how renewable energy resources can be integrated to supply both heat and power to any area where there is a high density of buildings such as industrial centres, villages or towns.

In future careful consideration might well be given to the positioning of any new power station, apart from the usefulness of the heat energy, one has also to consider the expense of pylon and cable installations across the countryside. In the future many more localised generating stations fired by a variety of fuels will provide combined heat and power and so overcome the distance obstacle. Also optimising power lines to the shortest path routes using mathematics with computing power will minimise power losses in cables. One such project is to build a power station at Newbridge on Wye powered by fast growing willow trees, a sustainable biofuel that would be harvested regularly in nearby fields. New willow saplings would be continually planted. The proposal is that it would be a combined heat and power system but more importantly from an environmental point of view, it should be a zero contributor of CO_2. This means that the amount given out by burning should match the amount of CO_2 taken in by the willow in the act of growing.

One thing is certain that in future with ever increasing energy costs, the concept of trading heat will become a more attractive and economic proposition, whether it be for inter-commercial exploitation on industrial estates or at a domestic level on housing developments.


Cross section of Heat Main of CAT, showing the flow and return within foam insulation



Microprocessor TEMPERATURE CONTROLLER

John Mosely evaluates the Velleman Temperature Controller and Sensor

The Velleman temperature controller is somewhat unique in that it contains two independently adjustable channels - one that can control a 'high' temperature to turn a fan on for instance, and one that controls a 'low' temperature to control a heater etc. Additionally, each channel has adjustable hysteresis. The outputs are via separate 5A relays so that reasonably heavy loads can be accommodated. For measuring the temperature a separate sensor board kit is included. The actual temperature sensor is off-board and connected to the sensor board by screened cable, where it is converted to a pulse width modulated output to the temperature controller board. This allows the sensor to be some distant from the controller board and not be affected by noise. Additional temperature sensors are available, and if a small switch box is used then several different temperature zones can be monitored. An in-built clock is also included.

As a practical example you may wish to keep a room at 20°C. You can select the high temperature to be 24°C, at which point a cooling fan is switched on. This fan would then be switched off when the temperature falls to 20°C. Similarly, if the temperature falls to say 17°C a heater is switched on which will also be switched off when the temperature reaches 20°C. In passing, our photographer is particularly interested in this project, for he needs an accurate method of temperature controlling his processing tank. The sensor head he currently uses has a short life and is expensive to replace - more than the cost o this kit in fact!

Specification

Temperature Controller

- High & low temperature control output with LED indication
- 220V AC/5A relay outputs
- Celsius temperature readout
- ±0.1°C accuracy
- -40°C to +150°C readout
- 24 hour clock
- Control range from -50°C to +154°C
- Hysteresis available per output
- Separated opto-coupler sensor input
- 9V AC/300mA power requirements

Temperature Sensor

- 200μs/°C pulse width
- pulse width at -40°C is 2ms (±500μs adjustable) and at 150°C it is 40ms (±2500μs adjustable)
- <0.5% linearity (-10° to 50°C) <2% full range
- 15mA current loop output
- Can be used up to 50m from controller
- 12V/20mA DC supply requirements

Construction - Sensor

This comprises of one small PCB and the sensor, which is mounted of the board, and the circuit is shown in Figure 1. As usual start with the resistors first. Note that two resistors (R2, 7) are mounted vertically and it is recommended that th bodies of the resistors be mounted on the corresponding marked large circle on the PCB legend. This will make calibration easier, as these resistors are used as monitorin points. Next the diode, small capacitors, IC sockets and electrolytics can be mounted, paying the usual attention to polarity. Finally, the three multiturn pots and the screw connectors can be fitted. Now fit the two ICS in their respective sockets.

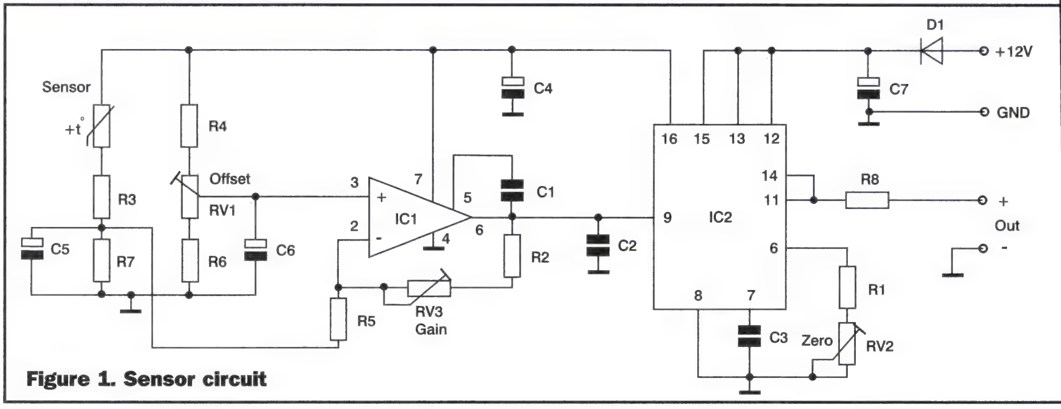
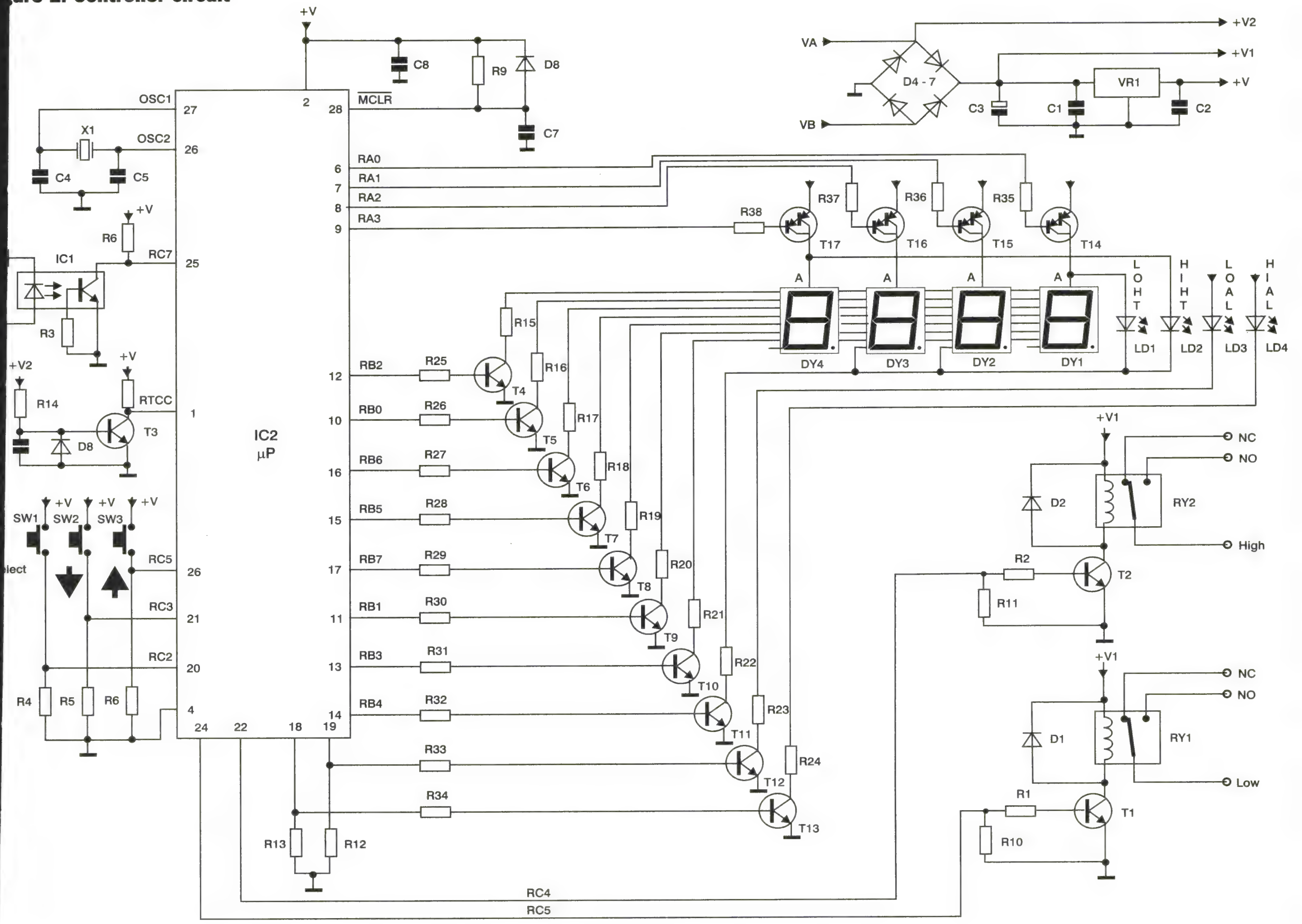


Figure 1. Sensor circuit

ure 2. Controller circuit



Solder a length of screened ire to the KTY10 sensor - olarity is not important - and uitably insulate the solder oints. A length of heatshrink ubing is included to cover the oints and part of the body of he sensor. This is important ecause you will need to mmerse the sensor in freezing vater later.

onstruction - emperature ontroller

he temperature controller omprises of three equal sized CBs - power supply, processor nd display boards - that are tacked and secured to an luminium front panel. This helps to simplify housing and esults in a compact final ssembly. The circuit diagram is hown in Figure 2. Again, it is advised that the small components are mounted first followed by electrolytics, IC sockets, connectors, relays etc.

It is suggested that the power supply board is constructed first, which also includes the opto-coupler input circuit and the output relays and driver circuits. Note that the 7805 voltage regulator is horizontally mounted on and bolted to a small finned heatsink, which will require the three IC legs to be carefully bent through 90°.

Now you can move on to the processor module, which requires initially three wire links to be soldered in. The crystal also requires a solder strap to secure it to the board, which is done first before soldering the crystal legs in. The rest of the board is relatively straightforward.

Finally, the display board is constructed, and again several resistors are mounted vertically. The transistors when mounted should not exceed the height of these vertical resistors, otherwise you will have problems stacking the three boards together. Be careful to check the polarity of the displays - the decimal point should line up with legend on the PCB. Similarly, the LEDs should not protrude above the height of the displays.

Now thoroughly inspect and check the boards for any obvious soldering problems, because once the boards are stacked it will be difficult to rectify dry joints etc. When you are happy that all is correct, then you can mount the boards together.

Final Assembly

Firstly, solder the connecting board wire links to the display module. If the links are progressively cut slightly shorter each time then it will help to align with the holes in the processor board. The display module is attached to the front panel by four 45mm bolts, four 10mm spacers, and nuts. You should now check that the displays are flush with the front of the panel. Now carefully push on another set of spacers followed by the processor module (components facing the display board), and align the connecting links. Secure the processor board with four nuts. Carefully solder the link wires using a small tip

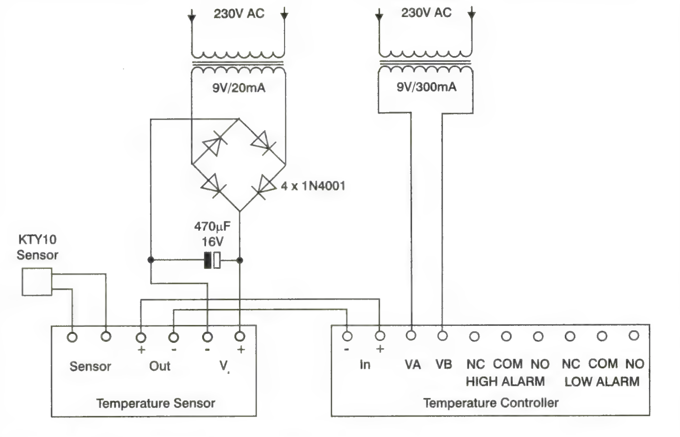


Figure 3. Connecting the modules

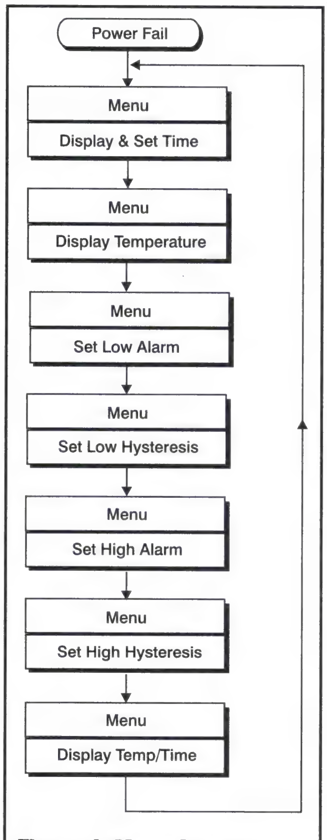


Figure 4. Menu function

soldering iron. Again, use another four spacers and push on the supply board with the track facing the processor board, and secure with four nuts. Push through the link wires on the last two boards and carefully solder in place.

Alignment

The temperature sensor needs to be on for about 10 minutes to allow the circuit to 'warm-up' and stabilise. Note that if you are measuring temperatures below 0°C and above 70°C then you should keep the electronics away from such temperatures, and connect the sensor remotely. Figure 3 indicates how the modules should be powered. Connect a digital multimeter across R2 and R7, and avoid touching the board during this alignment as it can induce noise and produce an unreliable readout.

While the circuit is stabilising, fill a small glass with ice cubes and water and allow the water to reach 0°C. Place the temperature sensor (KTY10) into the melting water (it is important that the connecting leads are suitably insulated). Now adjust the OFFSET trimmer, RV1, so that the digital multimeter reads 0V - use the most sensitive range possible - and wait for the reading to become stable. Take time and effort to get this right, as it will influence the correct operation of the system.

Now connect the temperature controller board to a suitable AC power supply - see Figure 3 - and you should get a FAIL display, which is correct, and you will see this every time there is a power interruption. The power supply of the sensor must be kept separate from the controller power supply. The controller board can be used to provide power (12V DC) for up to four sensor boards. Note that the controller will not work, and that includes the clock, until the sensor module is connected.

When the two modules are correctly connected and powered, the FAIL indication will be displayed. If you now press the PUSH button you can toggle through the different modes of display. The time and alarm settings can be selected by the UP and DOWN buttons. Note that there is a slightly delay (0.5s) in the button action to avoid contact bounce. To go through the menu quickly keep the button pressed down. The menu sequence is shown in Figure 5.

Now re-immerse the sensor probe into the melting ice again and adjust RV2 so that the display reads 0°C and wait for the reading to stabilise. If you intend to operate the sensor at room temperatures then allow the sensor probe to stabilise at room temperature, and adjust RV3 to read the room temperature. Obviously, it will be necessary to compare readings with a quality thermometer. If you wish to use the sensor above 40°C then the last adjustment should be made in boiling water e.g. a known source at 100°C. It is worth repeating all this alignment procedure to ensure the readings are correct.

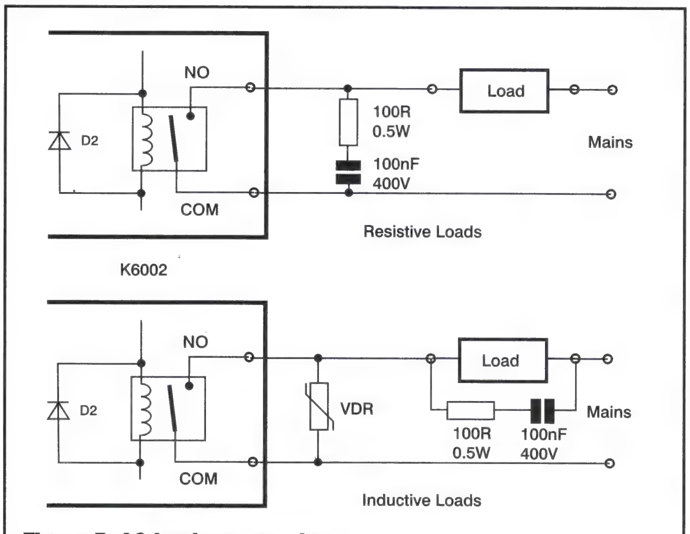


Figure 5. AC load suppression

In-use

It is very simple to set the controller by just sequencing through the menu and selecting the desired time/temperature using the UP/DOWN buttons. The corresponding LED will light when that function is select.

If you intend to switch AC voltages then you may need to use suppression circuits as shown in Figure 5. The VDR in the inductive load circuit will need to be rated at mains voltage.

Conclusion

This is yet another excellent kit from Vellman that can be used for a variety of temperature monitoring applications. The finally assembly can be tricky, so care is needed at this stage, but the effort is worth it. The whole system can easily be mounted in a small rugged box and a front panel label is supplied to complete the kit.

TEMPERATURE SENSOR

RESISTORS:

R1	240k
R2	18k
R3	3k
R4	4k7
R5	10k
R6, 7	1k8
R8	560R
RV1	1k Multiturn Trimmer
RV2	200k Multiturn Trimmer
RV3	5k Multiturn Trimmer

CAPACITORS

C1, 2	470pF Ceramic
C3	47nF polyester
C4-6	10μF 16V Elect
C7	220μF 16V Elect

SEMICONDUCTORS

D1	1N4001
IC1	3160
IC2	3524
Sensor	KTY10

MICROPROCESSOR TEMPERATURE CONTROLLER

RESISTORS:

R1, 2, 4-8, 25-38	4k7
R3, 10-14	47k
R9	1k
R15-24	270R

CAPACITORS

C1,2,7,8	100nF Ceramic
C3	2200μF Elect
C4,5	18pF Ceramic
C6	10nF Ceramic

SEMICONDUCTORS

D1,2,3,8,9	1N4148
D4-7	1N40001
T1-13	BC547
T14-17	BC516
IC1	4N27
IC2	VK60002 (Velleman)
VR1	7805
DY1-4	TDSR5150 7-Segment LED Display
LED1-4	3mm Red LED

MISCELLANEOUS

RY1,2	12V DC Coil 5A/230V Contacts
SW1-3	Push-to-Make
	Heatsink
	Crystal
	Screw Terminal Connectors
	9V/20mA Transformer
	9V/300mA Transformer
	Suitable Box
	Hardware
	Heatshrink Sleeving

Type	Order Code	Price
Temperature Controller	VE69A	£59.99 (includes one VE68Y)
Temperature Sensor	VE68Y	£14.99

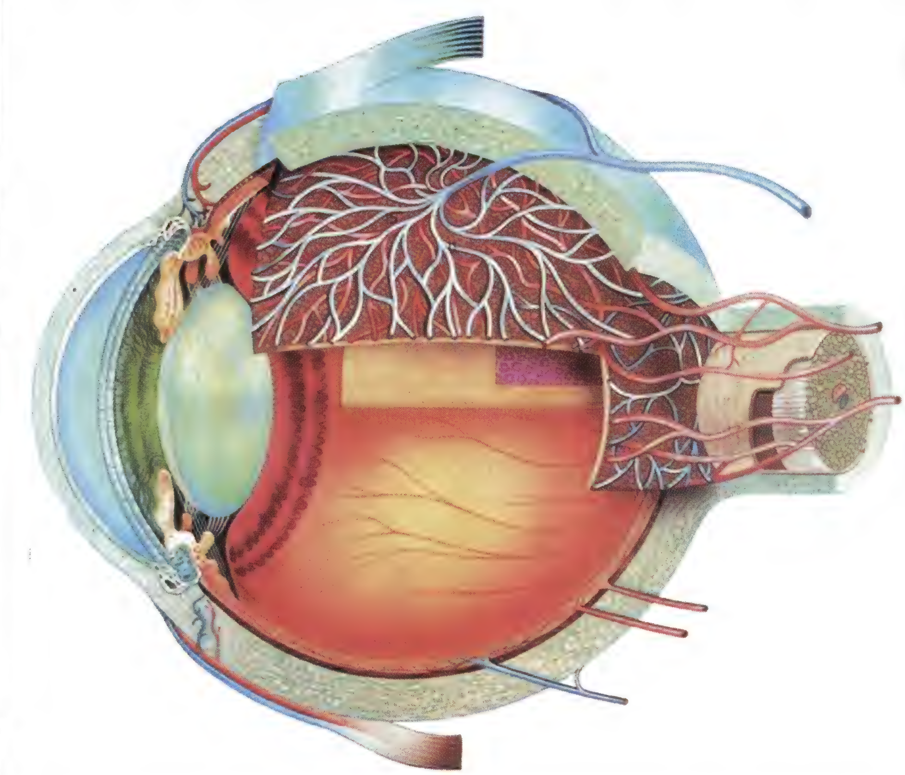


Figure 1: Anatomy of the eye indicating cornea, aqueous humour, lens, vitreous and retina.

Laser Battlefield OF THE FUTURE

Douglas Clarkson reports on the eye damage that can result from current and future laser warfare

Introduction

Since the laser was first invented its incorporation in technology has been rapid and highly significant. While we have open access to information in the area of telecommunications, industrial and medical use of lasers, the level of data regarding military applications is as expected much more limited.

Laser technologies, however, continue to increase in significance in modern theatres of war. We all perhaps still remember clips of the Gulf War and then the Kosovo conflict where laser guided devices or munitions were targeted with so called pin point accuracy. There has been, however, increasing anxiety over various weapons programmes around the world which use lasers as counter measures against installations and directly/indirectly against personnel.

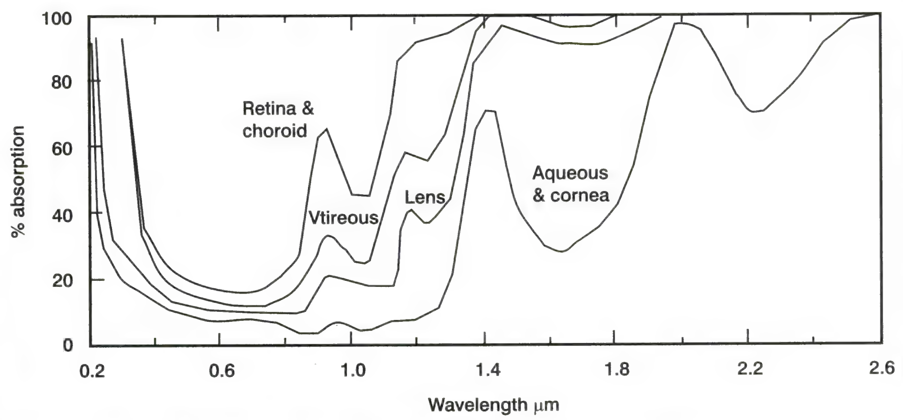


Figure 2: Relative transmission of light through components of the eye.

As a result of the deployment of such systems, there is the real risk that casualties of future wars will include those whose vision is impaired due to interception of such beams. This would have considerable significance for the provision of medical care of such casualties who would invariably require to be evacuated to receive appropriate specialist treatment. Also, for more severe retinal injuries, treatment is very limited.

Nature of Risk

It is relevant to consider aspects of the nature of interaction of laser radiation on the eye. The eye, as indicated in Figure 1, consists of key components of the cornea, aqueous humour, lens, vitreous and retina. Figure 2 indicates the relative transmission of light within these various components. Within this context, light is taken to mean electromagnetic radiation within the range 400nm to 1500nm. Naturally the eye is most receptive to visible and near infra red radiation. With ultra violet radiation, there is increased absorption in the cornea/lens and with infra red, the cornea becomes more highly absorbing.

Laser energy incident on the retina can readily damage its delicate structures. Wavelengths of longer values tend to penetrate more deeply into its various layers. The normal focusing action of the cornea/lens can in fact increase the energy density at the retina by a factor of 100,000 compared to the levels incident at the cornea. In regard to the hazard of battlefield laser systems, the use of binoculars etc can also act significantly to increase the risk of associated ocular injury.

International standards (such as BS EN 60525-1) have classified the degree of risk that laser radiation currently presents. There is, however, a lack of information on the risks of laser pulses of ultra short duration - of pulse lengths shorter than a nanosecond and behaviour is extrapolated from data at longer pulse durations.

A key term is the MPE or maximum permissible exposure and is the level of exposure that the eyes can safety tolerate. Figure 3 indicates the value of MPE at the cornea for single exposures of laser radiation within the wavelength range 400nm to 700nm and 1050nm to 1150nm for a range of pulse durations. Normally the MPE will be a function of both wavelength and pulse duration but for these specific wavelength ranges, the MPE is only a function of pulse duration. For the range 400nm to 700nm, for example, the MPE value is constant for pulse durations less than 0.1μs. With increasing pulse duration beyond this value, the MPE increases, presumably as the laser energy is more readily conducted out of the incident area. This indicates that for a given value of laser pulse energy, this will tend to be more damaging if delivered in pulse duration

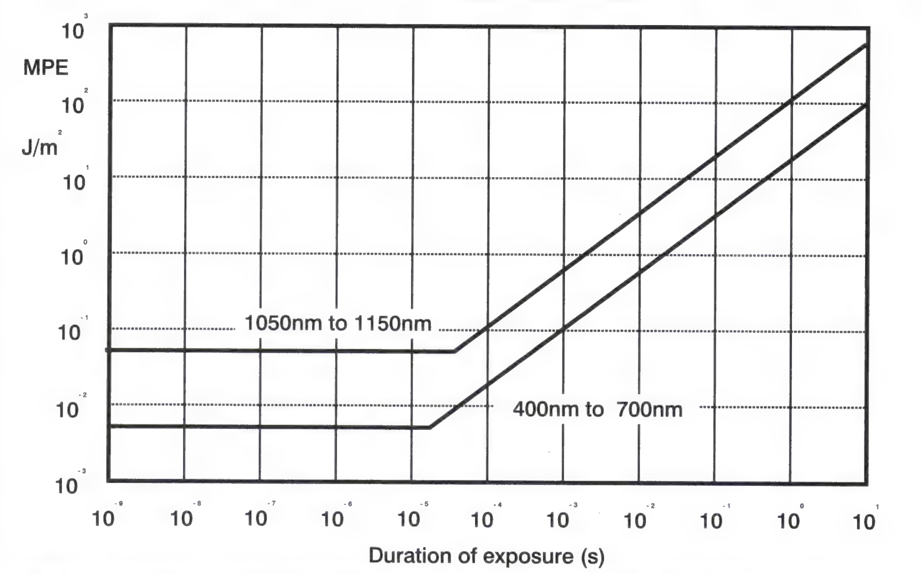


Figure 3: Values of Maximum Permissible exposure for single exposures of laser radiation in wavelength ranges 400nm to 700nm and 1050nm to 1150nm

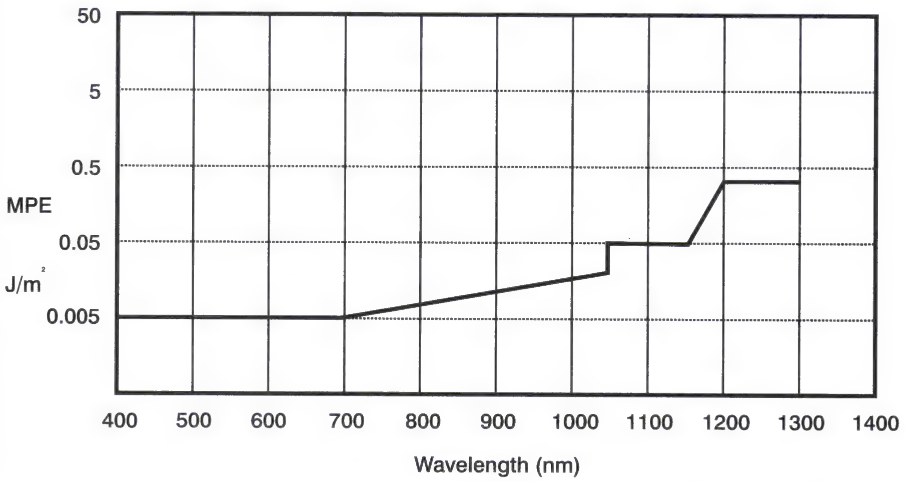


Figure 4: Variation of Maximum permissible exposure with wavelength at a nominal pulse duration of $1\mu s$.

shorter than a specific limiting value.

Also, Figure 4 indicates the variation of MPE with wavelength at a specific pulse duration of 1 micro second. This indicates that the eye, for the wavelength range presented, is most vulnerable in the optical range. Where non-visible laser weapons are being developed to deliberately impair the vision of targeted personnel, the wavelength range around 800nm would be particularly dangerous. The Alexandrite laser with a wavelength of 755nm, is just on the limit of vision. These estimations, moreover, give indication of values of MPE associated with single pulse exposures. Multiple exposures fired closely together in time would carry additional risk - and associated with reduced values of MPE.

The threat of use of such devices is not restricted to future areas of conflict. Already, for example, pilots of commercial air flights have been deliberately exposed to dangerous levels of laser radiation. Such data is, for example, recorded in the NASA Aviation Safety Reporting System database. At least 50 such incidents have been reported to date in the USA.

Classification of Battlefield Systems

A committee of experts convened by the International Committee of the Red Cross met in 1990 to develop a classification system for battlefield lasers. Category A w defined as systems not primarily designate for anti-personnel use but which under battlefield conditions might present an ocular hazard. Systems included within th group are range finders, target designator laser target markers, optical laser systems (LIDAR) and large, non portable or vehicle mounted systems. Even range finders are probably not eye safe and target designato utilise more powerful laser sources.

A sub category also relates to sighting, training, simulation and other small portal systems.

Thus category A devices are intended as information gathering systems, They shou be designed, preferentially, to discrete monitoring using low levels scanning beams.

Category B systems, however, are designated as anti-sensor systems and hav inherent requirement to have sufficient 'clout' to damage optical detection system Personnel in the vicinity of targeted installations will be at very high risk if not wearing appropriate eye protection.

Category C systems are so called anti-personnel systems. These are deliberately designed to damage the vision of a targette individual. Information on such devices is classified, though some snippets of data ar available. The British Navy, for example, developed the Laser Dazzle Sight (LDS) which was first deployed during the Falklands War but its development was stopped in May of 1995.

Category D systems are described as ant material systems. These include at one end of the spectrum the so called 'Star Wars' weapons for interception of missiles in space and at the other, systems to destroy munitions such as land mines.

Table 1 gives therefore a broad overview of a limited range of projects known at one time to have been under development. There is, however, considerable lack of data on the status of any specific project and als on its technical specification (not surprisingly). The LCMS system, has in particular attracted most of the recent discussion of such systems in the USA and i primarily a category B system. Developmen of such systems, however, is not limited to

Code Name	Functionality
Saber 203	Grenade launched shell that produces very intense light flash
Stingray	category B system for detecting and disabling optical scanning systems.
Dazer	Portable rifle like device operating at 755nm (Alexandrite).
Cobra	Portable rifle like device operating at 1064nm (Nd:YAG diode pumped)
Perseus Optical	40 mm rifle grenade projectile produces intense optical flash Munition
Coronet Prince	System for detecting and disabling ground based optical systems
Compass Hammer	Optical countermeasure system - probably deployed on F15E strike eagle aircraft
Cameo Bluejay	Helicopter mounted tactical laser weapon
Laser Countermeasure System	One person, portable shoulder fired, battery powered device mounted on M16A3 rifle.

Table 1: Various laser devices known to have been developed in the USA.

e USA, with developments in particular ing undertaken in Russia, various former viet Republics, China, France and Israel. Systems for laser neutralisation of unitions have been successfully tested ainst devices such as anti-tank mines, anti rsonnel mines and rifle grenades. Systems own to exist in the USA include MODS obile Ordinance Disrupter System) and us. Beam output powers are anticipated many hundreds of watts or several owatts. The effective range of such stems is designed to be up to 300 km. The e of such systems, however, would esent a risk to any personnel in the line of ht of the firing beam. Star Wars lasers or egawatt class continuous deuterium oride laser systems, are being developed part of 'directed energy' systems.

evelopment of rotocol IV

comes very much as a surprise to learn w long ago the effort was first made to nit the arsenal of war in an attempt to nit devices which would cause nnecessary human suffering'. The eclaration of St. Petersburg of 1868 was e first such resolution to seek to limit the e of specific weapons and was successful prohibiting the use of exploding bullets hich would serve to uselessly aggravate a mbatant's suffering.

It becomes clear that if nuclear weapons ad been developed within peace time, fforts would have been made to have their evelopment banned within the Hague onvention - in line with its remit for the revention of 'unnecessary suffering'.

Initial resolutions were further refined at e Hague Peace Conferences of 1899 and 907 and the so called Hague Convention ecame the basis for International Law in e waging of war.

The emergence of initiatives to restrict ser blinding weapons emerged out of a eries of meetings under the aegis of the nternational Committee of the Red Cross ICRC) and the United nations. Awareness f the threat posed by laser weapons was chieved by a 1980 UN conference though it as some nine years later that a more ocused perspective was available on the otential threat from a panel of experts who rew up the series of laser weapons ategories.

It was a review conference of 1995 that ubsequently drew up the so called Protocol V to the 1989 agenda and established the anning of specific use of lasers primarily ntended to blind.

The recent Kosovo conflict, however, ndicated the use of massive air force with revalent use of laser targeting systems in n effort to resolve a situation without ncountering ground based military asualties. This indicates the increasing olitical identification with high tech weapons systems designed to minimise the direct engagement of ground based forces.

The Pentagon Speaks

On September 1, 1995, the secretary of Defence William J. Perry, endorsed the international Ban on Futuristic Laser Weapons that were intended to cause permanent blindness. While giving encouragement to Human Rights Groups, there was at the same time indication given that the USA would seek to develop and maintain its perceived technological edge in all permissible categories of laser measure/countermeasure. Human rights groups, however, anticipate that Category B systems may be increasingly deployed in the future - giving rise to concern of infliction of severe eye injuries on personnel in the vicinity of targeted installations.

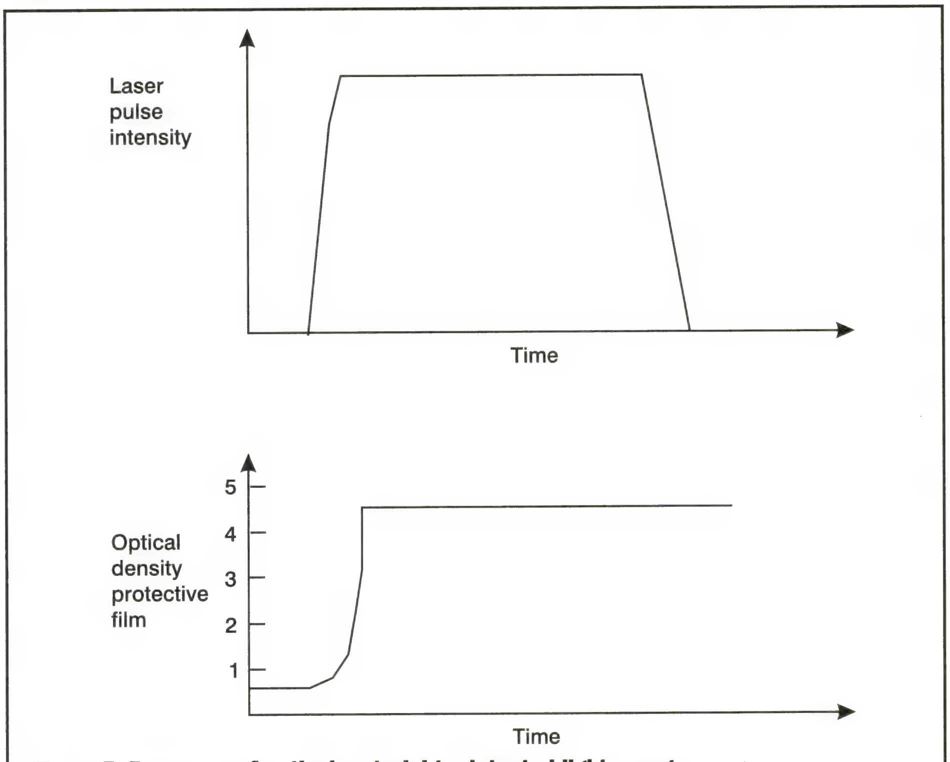


Figure 5: Response of optical material to detected light energy.

Enter The Dragon

A worrying feature of the proliferation of category C laser weapons has been the open development and marketing by China of laser devices openly claimed to be an effective anti-personnel laser device. The ZM-87 portable laser disturber was first displayed in November 1994 and has been supplied to various countries around the world. The nominal distance over which the device is effective is two to three miles. The device operates by transmitting 15 MW pulses at two different wavelengths simultaneously. The availability of such a device is working directly against the directives to ban the development and proliferation of such devices. There is even more concern that China has also assisted various countries such as Pakistan in the development of their own nuclear weapons programmes.

The recent debate on the apparent ease with which China can steal US military technology is also touching upon the development of laser weapons. China is already known to have considered development of anti-satellite laser weapons. Also, category D laser devices are considered by China to be the most effective countermeasure against Cruise missiles. Presumably as countermeasures, military satellites are probably already designed to withstand hits from such directed energy weapons.

Countermeasures

One of the hottest topics within the military sector at present is effective countermeasures against category B (and category C) laser devices. Since around 1970, in the US air Force, visors have been available which have provided protection against various fixed wavelength laser radiation. Initially, problems encountered were the fact that such devices introduced distortion into the visual field, or so reduced visible light transmission that night flying was rendered more hazardous while wearing such devices.

Improvements in quality of such devices, e.g. low distortion, better visible light transmission, etc have however significantly increased the cost of such devices, so much so that their deployment has been restricted - even for those in charge of an $100 million aircraft. The current state of the art visor provides protection against four visible laser wavelengths and three near infra red wavelengths.

The greater threat of ocular damage is associated with the so-called 'agile' laser, which can operate at many different wavelengths within a fraction of a second. The countermeasures against such a device are consequently more complex and are a key area of current military research and development. There is the perception, however, that in the escalation of technology, active threat and adequate countermeasure will be successively locked in a process of continuing and expensive linakge.

It is interesting to speculate on the possible options available to develop such devices. One comparable use of eye protection relates to safety visors used with arc welding units. Automatic devices can detect the presence of the arc and electronically increase the optical density of the visor material to the appropriate level of filter protection. For industrial applications the transition of light to dark can take place in 0.3ms. The reaction time is faster if the temperature of the filter material is increased. Figure 5 indicates in general terms how such a device operates. The application of such technology to the military sector, however, would be much more challenging, particularly where the duration of laser pulses could be too short to allow deployment of such 'active' protection devices.

There is perhaps an option, however, to develop some sort of intermediate device for the protection of, for example, air craft personnel who are already being targeted by ground based laser devices in the hands of thoroughly irresponsible individuals.

However, the area of so called optical switching, of the interaction of light/electric fields on the optical properties of materials has advanced significantly in recent years - especially in the area of 'optical' computers and spatial light modulators.

Development of countermeasures against so called agile lasers can be imagined to be high on the priority of military strategists and the technology accordingly highly classified.

The Future

We are very much in the dark regarding the specifications of devices in current categories of laser weapons. While the key element may be considered to be the delivered beam power or pulse energy, a great part of the effectiveness of any such system is going to be its detection and targeting capability. It is not unreasonable, however, to anticipate an increase by a factor of 5 in a period of 10 years in delivered power energy. This will serve to make such systems more lethal within existing ranges and also extend the range of delivery beyond existing values.

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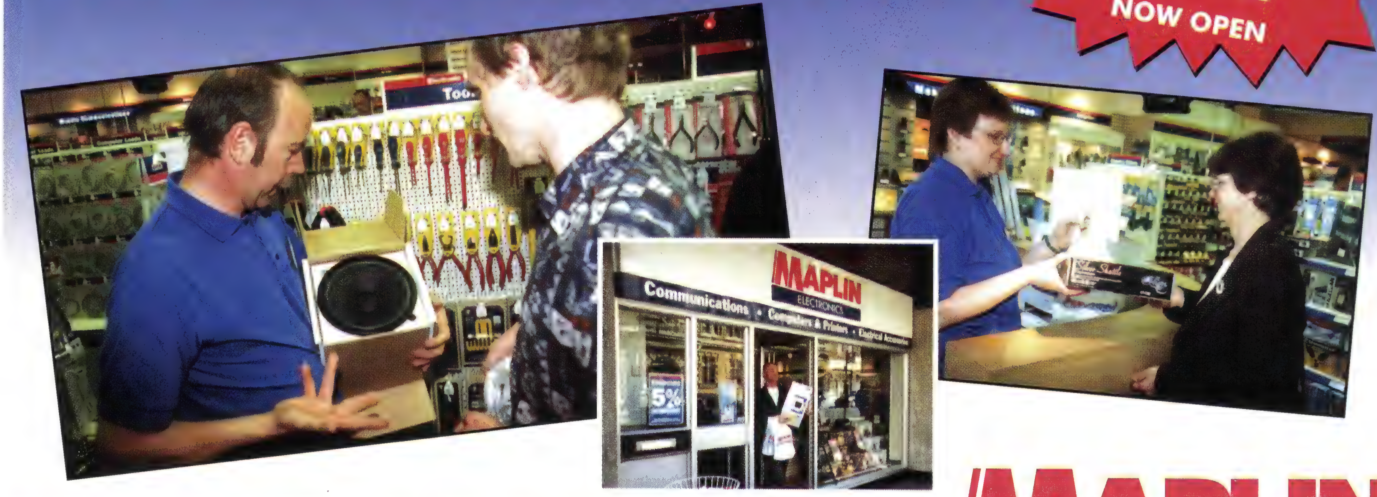
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RESEARCH NEWS

by Dr Chris Lavers

NASA's Remote Sensing Contribution to Medical Sensing and the Chemical Sensing Environment!

Over the last year or so and certainly the last few months there has been considerable press and recent public awareness on the issue of successful early cancer detection, breast cancer in particular, and we have tried to follow some of the current developments in this area.

A great deal of work has been conducted in recent years by NASA directly into medical sensing, with their desire for telemedicine (medical procedures that might need to take place in space remotely involving personnel with little or no specialist medical background). In addition NASA's wealth of scientific instrumentation and experience has often resulted in technologies spinning off benefits into completely unexpected areas.

Medicine today already has an undreamed off available range of body-scanning equipment and techniques available to create images inside the human body to aid physicians in diagnosis, treatment and surgery than even twenty years ago. Perhaps surprisingly a significant amount of this scanning ability has grown out of a space data analysis technique known as Digital Image Processing. This was developed as a means of assembling planetary pictures from streams of digital data bits sent to Earth by distant spacecraft sensors, which by today's standards were at appallingly slow data rates! Image processing technology has been employed in X-rays techniques via Computer-Aided Tomography (CAT) scanners, diagnostic radiography, brain and cardiac angiograms and ultrasound body scanning (routinely used in pregnancy ante-natal care).

With the help of innovative technologies from the Hubble Space Telescope breast biopsies to detect cancer may now be performed virtually pain-free and very importantly scar-free with a small needle rather than scalpel. Breast tissue can be imaged more clearly than conventional X-rays, using sensitive silicon chip devices and the patient can rapidly resume the normal activities of daily life.

Charged Coupled Devices (CCDs) are basically silicon chips that convert light directly into electronic or digital images. Goddard Space Flight Centre headed the development of the advanced, supersensitive CCD installed into the Hubble Space Telescope in 1997. Subsequently the LORAD Corporation of Danbury, Connecticut, USA adopted this new CCD for its breast biopsy system (Figure 1). Through this system, the patient lies face down with one breast protruding through an opening to pinpoint the area in question. LORAD's new CCD based procedure saves the patient time and pain, and leaves only a small needle mark rather than a large scar.

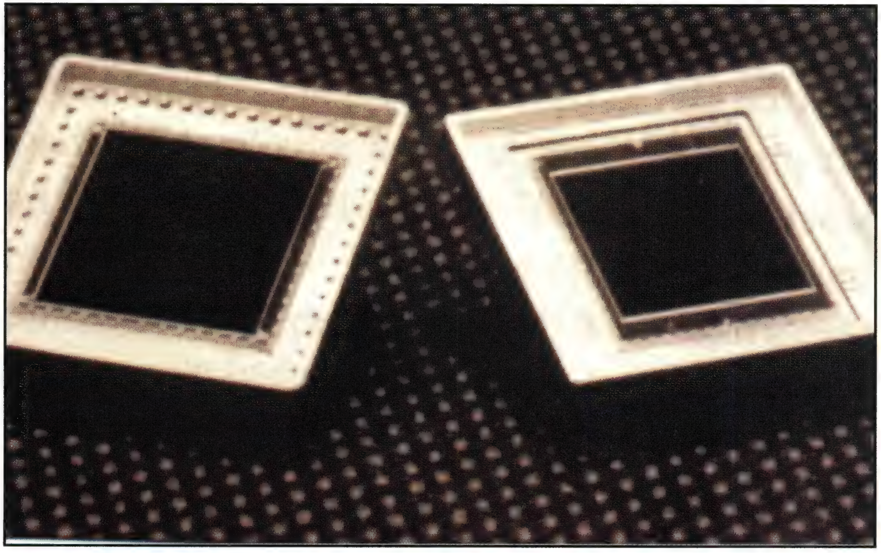

Figure 1. The CCD chip based breast biopsy system commercialised by LORAD Corporation. The CCD on the left is the extrasensitive device developed for the Hubble Space Telescope. The virtually identical CCD on the right is used by LORAD Corporation. Courtesy NASA.

In the mid-1960's the Jet Propulsion Laboratory (JPL) in California developed Digital Image Processing to allow for computer software image enhancement of Moon photographs with the aim of finding a suitable lunar landing site before the decade was out. Physicians use digital image processing now to record images of organs in the human body and with the advent of the internet and digital data transmission, to transfer this information rapidly between specialists with no loss in image resolution and clarity. Magnetic Resonance Imaging (MRI) uses a magnetic field and radio waves to create an image and then a computer will reconstruct the image. MRI is preferable for soft tissues whereas CAT scanning is used for bone, and the two systems should be seen as complementary and not excluding the other. Data specialists are currently working on data fusion systems to combine the best aspects of both systems to create a high quality composite image. Clear, accurate three-dimensional images as those in Figure 2 are made from a series of breast and tumour MRI scans, combined with reconstruction software developed at the Ames Centre for Bioinformatics. A breast image from a MRI scan following a contrast medium injection of gadolinium to detect the tumour shows the position of the mass within the breast (pictures middle and right).

The Bioinformatics Centre at NASA Ames is part of a much larger national Biocomputation programme established in Palo Alto, California. This national facility will be used to further virtual reality in medicine and hopes to accelerate the use of 3 dimensional and virtual environment technologies in science and space, as well as in medicine. The US Government aims to establish a virtual hospital, which in the not so distant future will link the best medical minds together from around the world to treat patients. Surgeons can use a

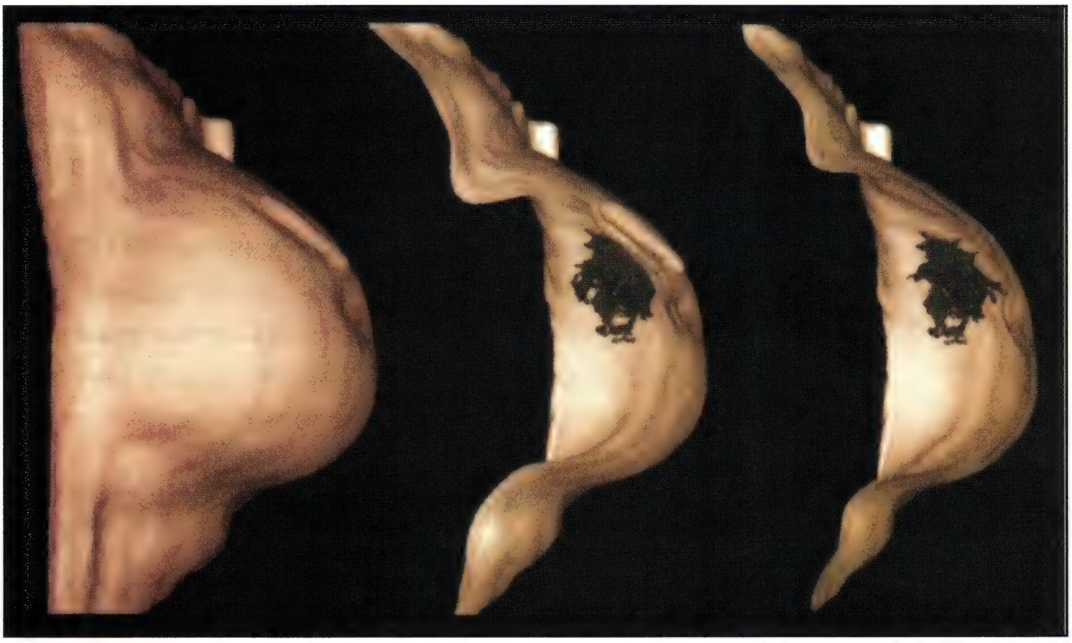

Figure 2. 3-dimensional MRI scan images from a breast with a tumour, combined with reconstruction software developed at the Ames Centre for Bioinformatics. Courtesy NASA.

variety of devices to manipulate 3D computer images of the patient. According to Dr Muriel Ross, director of the Centre for Bioinformatics at Ames "The physician can go in the night before surgery and use the computer in a virtual environment to actually walk through the operation." In the case of facial surgery, the surgeon can even use the virtual reality environment to replace soft facial tissues and see what the patient will be likely to look like after facial reconstruction. If the surgeon doesn't like what he or she sees, it can be repeated in a slightly different way.

Figure 3. ChemScan, able to detect any chemical substance that absorbs light in the ultraviolet or visible wavelength range. Courtesy NASA.

A new commercialised chemical sensor has come out of NASA's need for a water chemistry analyser for monitoring hydrophonic plant nutrients. NASA has a program to support developing systems which must resupply food, water and air, from the carbon dioxide the crew expels, from plants on long in-flight missions, e.g. to Mars. Water analysers originally designed under a contract sponsored by Kennedy Space Centre in Florida, are currently being commercialised. In 1998 Applied Spectrometry Associates (ASA), Inc. of Waukesha, Wisconsin added a new model to its ChemScan® product line. The UV-2150 Process Analyser is now being used to measure chemicals at public drinking water treatment plants and public wastewater treatment plants (sewage works!)

ChemScan (see Figure 3) can detect any chemical substance that absorbs light in the ultraviolet or visible wavelength range. Heavy metal compounds in water, nutrients, unsaturated hydrocarbons (double bonded or tripled bonded carbon-carbon atoms) and aromatics (benzene ring derivatives) are generally unwelcome but fortunately are usually good candidates for analysis using ultraviolet or visible spectrometry. Chemicals that possess natural absorbance characteristics can be detected directly. Reliability for these systems is high whilst at the same time the maintenance costs are low with only a few hours servicing required per month. Real-time chemical analysis, combined with modern communications could possibly have resulted in a very different outcome of the Camelford incident in North Cornwall 12 years ago. Unfortunately large quantities of Aluminium Sulphate (12 tons) which should have been added in very small quantities worked its way into the water chain and consequently affect about 20,000 people as well. Documented symptoms included cases of rashes, chemical burns and diarrhoea The long-term health effects o this incident cannot be underestimated. Data linked devices such as ChemScan ma very well help prevent similar future incidents occurring.

For further information contact:

NASA has a number of sites involved in virtual medicine activities:

`www.hq.nasa.gov/office/olmsa/aeromed/telemed/welcom`

`www.hq.nasa.gov/office/olmsa/aeromed/telemed/telemed/centers.`

Optical DNA Analysis Biochip Reader for GP Desktop Medical Applications.

Following on from sensors for early detection it would be eve better to detect a problem

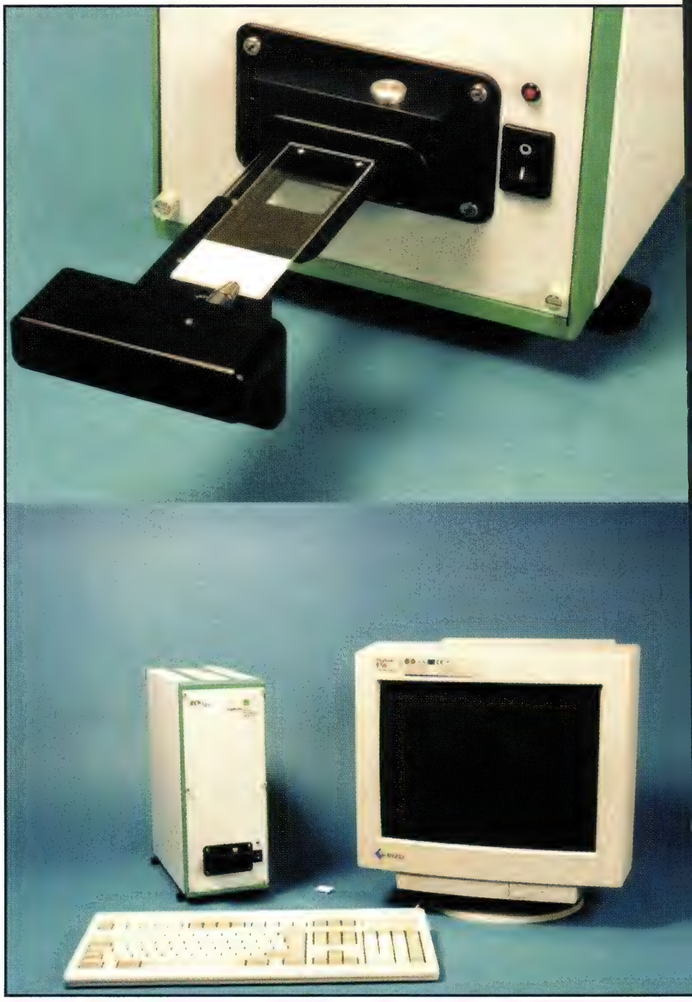

Figure 4. Optical Biochip Reader, Courtesy of IPM Freiburg

	Laser Reader	Multi-Colour Reader
xcitation Wavelength	640nm	400 to 800nm Up to 4 wavelengths possible
mission Wavelength	682 (+11)nm	400 to 800nm Up to 4 wavelengths possible
ixel array	762 x 512	762 (512
hip Size	1/2"	1/2"
iameter of each dot	50-90 microns	50-90 microns
etection Limit	6 x 10^4 molecules per dot	5 x 10^2 molecules per dot
aximum detection area	14 x 14mm ^{2}	14 x 14mm ^{2}
aximum number of dots	5000	5000
ize of device	180 x 470 x 380mm length x height x width	180 x 470 x 380mm length x height x width

ble 1 Technical data on Optical Biochip reader

fore it has begun. Workers at e Fraunhofer Institute for ysical Measurement chniques (IPM) have veloped a DNA analysis osensor that could analyse ood samples in just a few inutes while you wait in the octor's surgery. Their optical ochip could allow the rapid etermination of hereditary netic disorders, bacteria and en unauthorised genetic odification of food supplies.

A group led by Dr Hans-Peter ehr and Marketing Manager avid Hradetzky at the aunhofer Institute have been orking in this area since 1998 rgeting the development of rious rapid optical biochip aders. Dr Lehr discussed their opes for the future with me nd explained that currently bout ten people in total are volved in this work.

Currently we are working with e fluorescent dyes Cy5, Cy3 nd FITC," he revealed, " but e multi-colour reader," lanned for the future, "can be dapted to any wavelength etween 400-800nm".

Key DNA components linked o possible genetic problems, ill fluoresce under intense lumination or irradiation and ould be detected in this way. Veak levels of fluorescent adiation may be captured 'on-hip' in optical waveguides hich allow these DNA ragments to be detected ithout more complex mplification processes. Their rst reader (see Figure 4a) is a ingle fixed stimulation vavelength of 640nm, but a econd reader is being leveloped that uses a white ght source between 400-800nm. Because the 4 wavelengths can e chosen freely the detection ystem can be adjusted to specific requirements. The complete kit with user interface is boxed up in Figure 4b.

The optical device uses a microscope slide glass and DNA material is added over a small area. Treated DNA samples in an aqueous solution are then sprayed onto the optical chip. Once inserted into the reader the attached dye molecules, irradiated with laser light, fluoresce at several characteristic wavelengths which a sensitive camera then detects.

The Biochip Reader detects and processes the information in a very short time, and is designed to be both user friendly, at low cost and with a sensitive lower detection limit. The practical clinical implications to the GP or doctor in hospital are clear. The doctor will be better able to meet laid down targets for seeing patients in a minimum duration of time, which is also a benefit from the patients' point of view, as they wait to hear what their problems are, or the results of any predictive screening.

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New Superchip Fabrication Plant Co-operation

Latest news from STMicroelectronics and Philips Semiconductors is that they are set to expand their existing cooperation agreements by building a new pilot-line fabrication plant for deep-submicron CMOS production onto 12-inch wafers. As discussed in previous Research News on microelectronics there is a continual drive to smaller and smaller wafer features, which increasingly requires the cooperation of the existing players in the field, driven unsurprisingly by the cost of developing these new technologies. Individual companies are increasingly unable to meet these production line costs all on their own. Apparently Philips Semiconductors, an affiliate of Royal Philips Electronics (NYSE:PHG), and STMicroelectronics (NYSE:STM) will invest up to $700 million to build together an advanced 12-inch (300mm) wafer pilot-line fabrication plant in Crolles, France.

This new agreement expands upon their existing technology cooperation agreements that has been in place between these two leading semiconductor companies since 1992.

By developing deep sub-micron semiconductor processes to 0.10 micron and below, this new 12-inch pilot line will keep both companies at the leading edge of semiconductor technology worldwide. The pilot line will be designed initially to produce up to 1,000 wafers per week, with the potential to increase up to 2,000 wafers per week. Site preparation and building of the pilot fabrication plant will commence this month, with the first 12-inch wafers expected to be processed in around two years time.

"STMicroelectronics has a long track record of successful cooperation in several areas of activity with both customers, public research institutes and competitors, particularly in the frame of European R&D programs like Jessi and Medea," commented Pasquale Pistorio, President and Chief Executive Officer (CEO) of STMicroelectronics. "Our cooperation with Philips is an excellent example of the advantages of alliances in leading edge R&D activities: it has certainly contributed to the technological leadership position of both companies and has helped ST to gain new positions in the highly competitive semiconductor market."

The decision to build the new facility follows several years of highly successful cooperation between the two companies, which has already given both of them access to 0.18 micron logic CMOS technology and manufacturing at ST's existing wafer fabrication facility in Crolles, France. The new 12-inch pilot-line fabrication plant will also be located in Crolles, with each company having equal access to both its research and development and manufacturing capabilities. Both companies intend to develop shared CMOS processes at 0.12 micron, 0.10 micron and below. The cooperation will include advanced process technologies such as copper, low and high-k dielectrics, new transistor structures and other state-of-the-art process steps.

ST is already involved in a productive cooperation program with France Telecom R&D (formerly CNET) and with Leti (the research lab of the French Commissariat l'Energie Atomique - CEA). Philips will also contribute research results it obtains as a result of its recently agreed cooperation with IMEC of Louvain, Belgium.

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Further news of Philips latest research may be found at:
http://www.news.philips.com

Intelligent MACHINES

In this article David Clark examines how biomimetics and artificial intelligence are being used to make intelligent machines and systems.

Introduction

The new science of biomimetics is enabling engineers to develop materials and systems, based on the mechanisms of the natural world, that have an effectiveness and energy-efficiency previously unobtainable. A positive side effect is that this benefits all in terms of the potential for minimising the damage to the environment caused by the manufacturing and use of these commodities. The dramatic advances in the understanding of biological systems that have led to this have also made possible some new devices to add to the list of tools available to scientists to analyse both the natural and the man-made worlds. By using sensors that mimic the biochemical processes of living systems much greater sensitivity and accuracy is now available to monitor the environment and gauge the impact the industrial world is having upon it. These sensors also make possible more detailed study of the living systems from which they are copied - and this includes human biochemistry.

The development of these biosensors as they are called is being accompanied by the development of 'biomimicked' versions of the devices that appear at the 'other end' of any system, biological or otherwise. These are the actuators, and the actuators of the natural world are the muscles. The effectiveness of borrowing from the natural world and making these powerful and efficient devices in smaller versions than has been possible in previous man-made efforts is opening up new areas for progress in two fields that might initially be thought unrelated - bionics and space exploration. Add to this the capabilities of 'smart' materials and the advances made in artificial intelligence during the latter part of the twentieth century, combine these into 'intelligent' machines and systems, and an exciting twenty-first century beckons.

This article looks at some of the techniques, devices and materials that exist in these fields right now.

Input

Any useful machine of course takes some input, processes it and produces some output. Electrical and electronic engineers have for many years used sensors for monitoring physical parameters, temperature and pressure being two of the most common. The particular transducer converts the input energy to an electrical output, for example a thermocouple generates an electro-motive force betwee two wires of different metals due to the thermoelectric effect (see Figure 1).

Here there is usually no need to isolate the quantity being measured from the transducer. The temperature directly 'creates' an electro-motive force that can measured. The relative straightforward monitoring of these physical parameters i conjunction with some 'intelligent' softwa is the basis of now routinely available eng management systems for instance.

However physical parameters are also vital in the biological world, information about pressure being particularly vital in allowing the human hand to gently and safely hold delicate things or tightly grip large or heavy objects. The sensation of h and cold contributes to the prevention of the damage that can occur to biological materials and also gives further subtle information about the nature of an object being handled. Sensing of this type is something that has been lacking in previo attempts at not only artificial limbs but als remote arms for sampling in hazardous environments for example, nuclear materi being an obvious case in point. Perhaps a less obvious need for this sensing is in the tools that are being developed to allow 'remote surgery'. This will allow surgical procedures to be performed by 'robots', under the control of human operators of course, but operated and monitored via remote 'manipulators' and viewing devices passed through small incisions in the skin. This removes the need for major invasive surgery, reduces trauma and allows shorte recovery time with less scarring. The remo surgical instruments will ideally be operate via a glove-like device. The concept of wearing a glove fitted with transducers tha translates movement to a remote mechanic 'hand' is no longer new and has seen use i several 'virtual reality' systems.

However, the requirements for Minimall Invasive Surgery as this technique is called are especially demanding (imagine trying t tie stitches inside the abdomen for exampl by remote control) and research is underway to develop devices with sufficien flexibility to make this possible. Other specialist systems are needed in conjunctio with this, accurate three-dimensional imaging being especially important, but particularly relevant in a discussion about sensors is the development of tactile sensors that will transmit a sense of 'feeling from a remote location. Devices are being developed at the Universities of California a Berkeley and San Francisco that incorporat an array of capacitative sensors that respon to force hence deformation and transmit information to a corresponding array of pneumatically operated pins to provide a related profile. A system with sensors fitted to a remote mechanical hand and actuators attached to the operator's corresponding fingers would give the closest approach yet to achieving something as remarkable as th human hand and wrist. (See Internet site **`http://robotics.eecs.berkeley.edu/~mcenk/medical/`**)

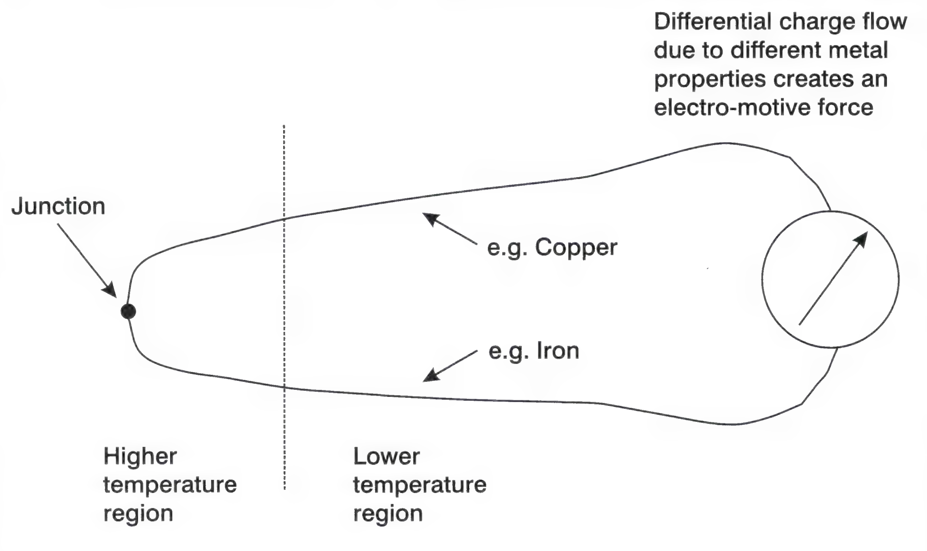

Differential charge flow due to different metal properties creates an electro-motive force
Junction
e.g. Copper
e.g. Iron
Higher temperature region
Lower temperature region

Figure 1.

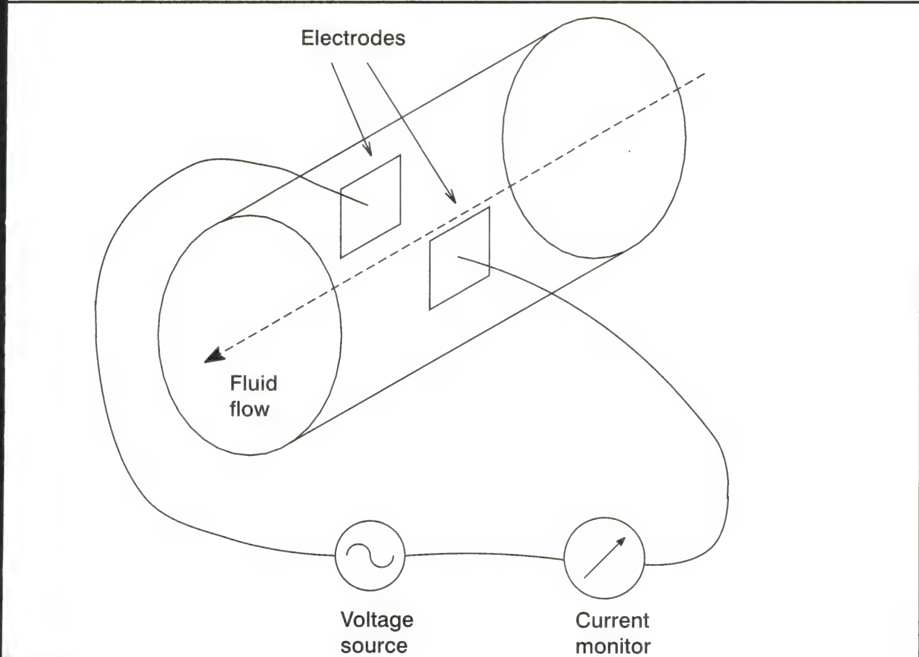


Figure 2.

lectrochemical ensors

hemical parameters have also been easured electrically for almost as long as hysical parameters. Perhaps the simplest ample of this is the case of electrical nductivity being used as a measure of the ncentration of a chemical substance in lution (see Figure 2).

This has uses that vary from measurements the effectiveness of water purification stems (absolutely pure water does not nduct electricity, it is the ions dissolved in that conduct), through mapping of the eans by means of the varying salinity of ifferent regions and depths, to medical eatments. (Haemodialysis machines, mployed in the treatment of kidney failure, se the electrical conductivity of the ialysing fluid to measure and control the ncentration of the ions within the fluid in rder that this matches the concentration of the same ions in the blood). The determination of the acidity of a solution (which is measured in pH units) is also an electrochemical measurement - the acidity of a solution is directly related to the concentration of hydrogen ions in that solution. This measurement too has widespread use in industrial processes, laboratory measurements and again medical diagnoses. The rate at which many chemical processes occur (or even if they occur at all) is dependent on the pH of their environment, and this is particularly true of living systems. Blood pH for example is maintained at a value of 7.4 by the chemical reactions of the body and any variation from this causes severe symptoms and even death if uncorrected. For pH measurements the electrodes need to be isolated from the solution and the interaction occurs via for example a glass membrane - see Figure 3.

The glass membrane is permeable to hydrogen ions and so these ions can diffuse into and out of the electrode assembly and cause a change in voltage between this electrode and another reference electrode. This type of sensor enables analysis for the presence of different types of ions as the electrodes can be designed to respond selectively to different ions. Other forms of ion selective electrodes available in addition to the permeable glass membrane ones include liquid-ion-exchange, solid-state ion-selective, and neutral-carrier ion-selective types. The liquid-ion-exchange types operate on the same principle as the ion-exchange water softeners often found in the laboratory and home in hard-water areas. In a water softener a 'soft' ion (usually sodium) bound to a resin substrate is exchanged with the 'hardness' ion (usually calcium) as it passes through the resin. In the ion-selective electrode however the ion-exchange material is in the form of a liquid held inside a membrane that is porous but repels water. The ion of interest passes through the membrane, is selectively exchanged, and the exchanged ion generates the electrical output from the internal electrode, which is sensitive to that ion. Solid state-ion selective types perhaps not surprisingly have a solid ion-permeable material acting as the membrane. The neutral-carrier type replaces the liquid ion-exchanger with a substance that selectively combines with the ion under analysis, and this is where the sensor action begins to come closer to that of the latest device in the development of transducers for monitoring biochemical processes - the biosensor.

Biosensors

Biosensors take advantage of the very specific activity of a biological component such as an enzyme, an antibody, a nucleic acid, a complete biological cell or even a complete micro-organism, to monitor the concentration or activity of a very specific substance. (See the box text on enzymes.)

The biological component is made to be in close conduct with a transducer that uses the product of the biological component, usually hydrogen ions, electrons or electrical charge, to generate or control an electrical signal. The biological component is 'fixed' in a gel or 'behind' a permeable membrane. See Figure 5.

The by-product then causes a measurable electrical effect by a secondary process, for instance if the by-product were hydrogen ions then the transducer would be a pH electrode. In the case of electrical charge being the by-product the transducer might be a Field-Effect Transistor (FET) with the gate being in intimate contact with the biological agent so that it directly controls the current through the transistor. This highlights another aspect of biosensors - the increasing integration of biological agents with electronics. Furthermore electrical and electrochemical effects are not the only methods of linking the biosensor to its associated analytical system. The optical qualities of biological substances can also be exploited where they change when the substance reacts, as can temperature changes. Biosensors have enormous potential for analysis from a wide range of

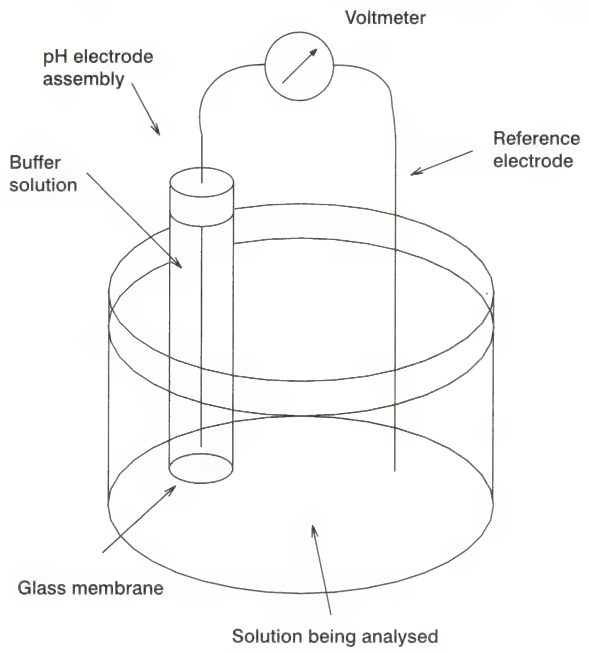


Figure 3.

Enzymes

Enzymes are the catalysts of the biological world, in other words they speed up reactions that otherwise would be very slow or not take place at all. As with physical and industrial catalysts, enzymes are unchanged at the end of the reaction that they facilitate and are ready to take part in the catalysis of yet more reactants. Unlike most physical catalysts though enzymes are extremely specific in which reactions they enhance, usually only catalysing a single reaction of a single substance. This is because their action is based on the physical shape of the protein molecule which makes up the enzyme (all enzymes are proteins) and the physical shape of the reacting molecule. This is often called the 'lock and key' hypothesis, and Figure 4 shows how this works.

Enzymes work by reducing the energy needed for a reaction to take place. A stable molecule has a certain 'energy level' associated with it as a result of all the bonds between the atoms within the molecule. If the molecule can break down into say two other molecules the sum of the energy levels associated with the 'product' molecules will be less than the original molecule. But there is an energy 'barrier', which is called the activation energy, that the molecule must overcome for the reaction to take place (otherwise the molecule would spontaneously break down anyway). When the enzyme and the molecule 'lock' together the energy associated with the bonding within molecule is reduced and bonds can be broken ie the reaction takes place. The products are then released and the enzyme is ready to catalyse the reaction of another molecule.

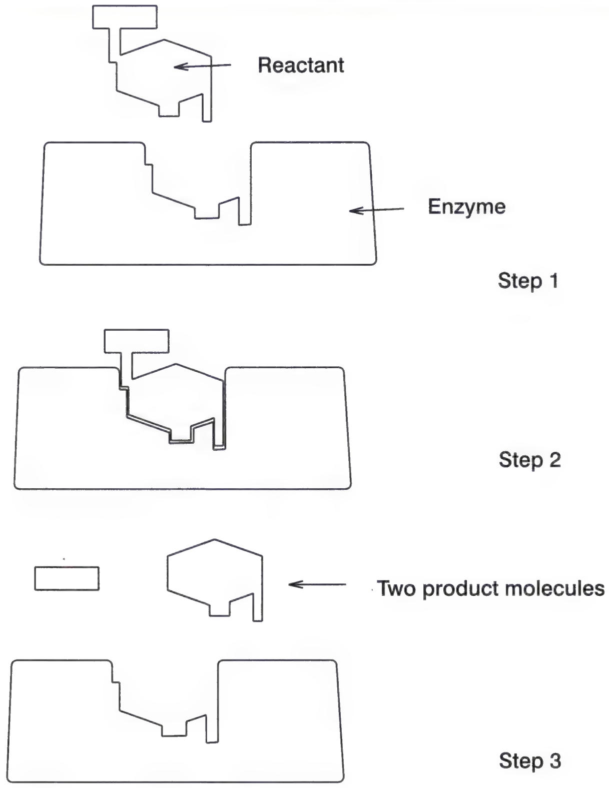


Figure 4.

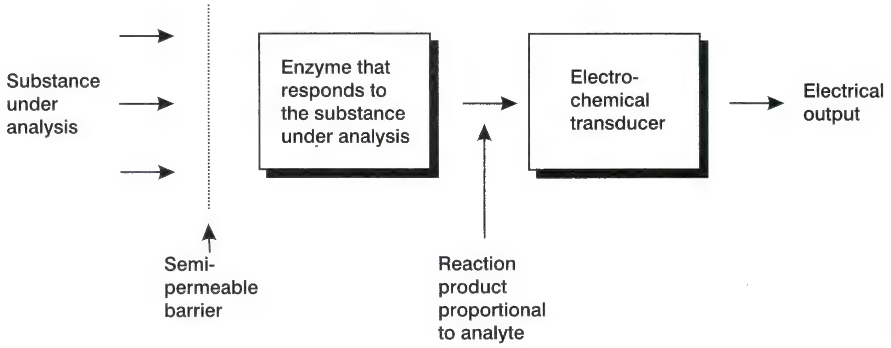

Substance under analysis
Enzyme that responds to the substance under analysis
Electro-chemical transducer
Electrical output
Semi-permeable barrier
Reaction product proportional to analyte

Figure 5.

substances in devices that are becoming increasingly miniaturised and capable of operating in increasingly remote and unattended locations.

Analysis Systems

As with other sensors, biosensors are used in two ways; in 'one-shot' measurements and in continuous monitoring. One-shot measurements are perhaps most frequentl used in medical situations, for example a biosensor based on the enzyme glucose oxidase is at the heart of a hand-held devic used to monitor blood sugar levels in diabetes sufferers. 'Throw-away' electrodes that measure up to sixteen substances, including glucose, lactate and urea, are increasingly being used in hospital critical-care and ward environments. Continuous monitoring electrodes are more frequently found in environmental monitoring situations for quantifying levels of hydrocarbons, halo-organic compounds an insecticides. (See `http://www.cranfield.ac.uk/biotech/chinap.htm`)

Output

A fascinating area of development at the 'other end' of the system is the interest in the use of artificial muscles as actuators in place of motors. In many applications, and again the improvement of artificial limbs is significant domain, the poor ratio of power to size, weight and energy consumption of motors plus gears and hydraulic systems is major drawback. In another triumph for biomimetics, science is again looking to copy nature to obtain improved performance in this area by employing artificial muscles. The improved characteristics of these are also of great interest to those involved in the sending of remote explorers into space and onto the surface of planets, their moons and in the near future asteroids.

One example of an artificial muscle is in fact extremely simple in principle. It consist of two electrodes separated by a compressible polymer film or polymer hydrogel, a structure known as an Electroactive Polymer (EAP). See Figure 6.

When voltage is applied to the electrodes the electrostatic forces of attraction cause the electrodes to move towards each other, squeezing the polymer outwards in all directions. When the voltage is removed th polymer automatically regains its original dimensions. The electrodes too are made o a flexible material and by rolling and folding the structure into a cylinder a linear actuato can be obtained. Interestingly this action mimics the behaviour of simple creatures that have soft bodies of fixed volume. Circular muscles around the body cause the body to thin and elongate when activated and when relaxed the body assumes its normal dimensions. In these creatures this allows simple movement. See Figure 7.

A more 'state-of-the-art' material being looked at, as a possibility for use in artificial muscles, is a carbon 'nanotube' based type. This material consists of 'cylinders' of carbon molecules only a nanometre in diameter that expand under the influence o

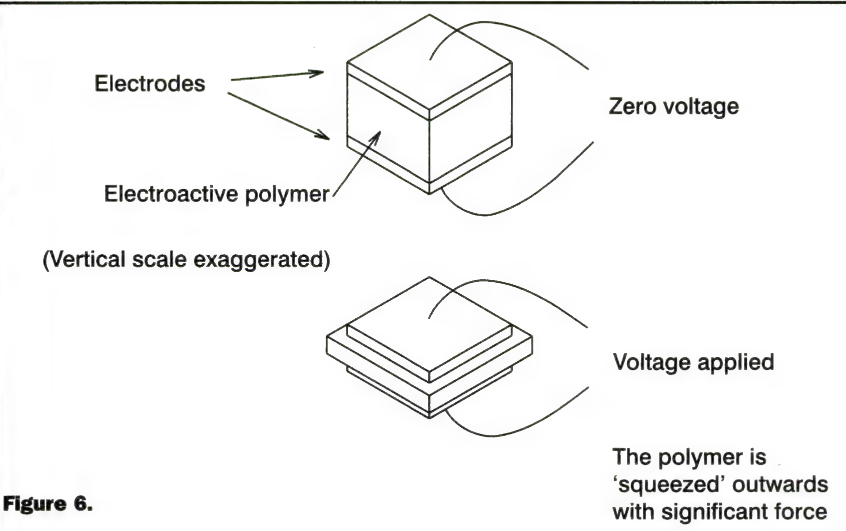

Electrodes
Zero voltage
Electroactive polymer
(Vertical scale exaggerated)
Voltage applied
The polymer is 'squeezed' outwards with significant force

Figure 6.

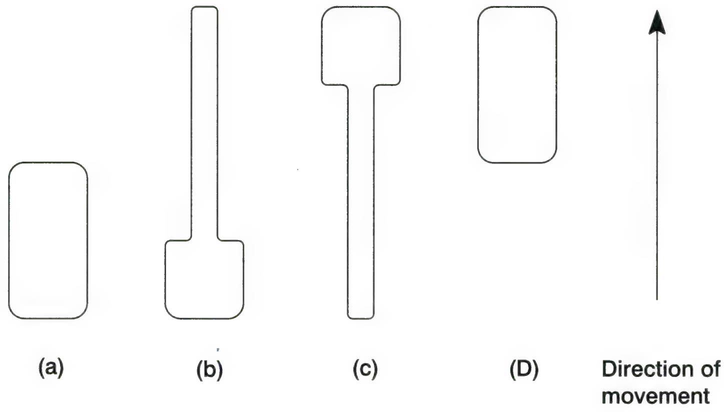
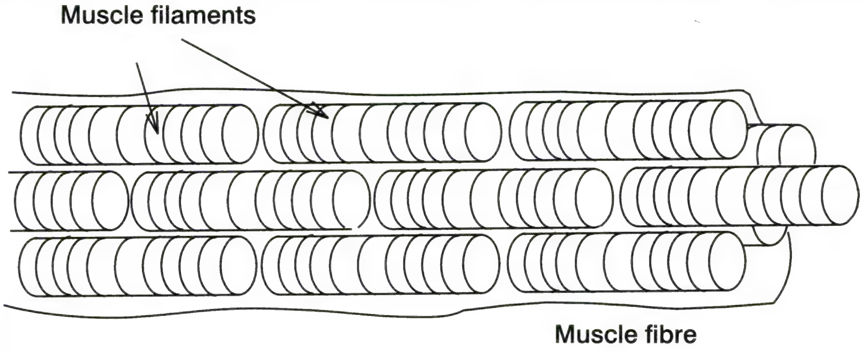


Figure 7. Simple creatures e.g. The earthworm, move by changing body shape. The internal volume of the creature remains constant.



Although each muscle filament can only contract a small amount, the co-ordinated action of many gives a highly efficient muscle action

Figure 8.

n electric charge and contract when it is emoved (BBC News Online May 20 1999). lthough the expansion is only by around %, if the nanotubes could be formed with a igher degree of organisation they could erhaps be made to behave like human muscle. The phenomenal contraction and trength of the human muscle is a onsequence of the behaviour of the nnumerable muscle molecule filaments round 1μm in diameter of which it onsists. Although each filament only hanges in size by a very small amount when the molecule changes shape, they are all highly organised within the muscle and act in a co-ordinated manner when the muscle is stimulated by its nerve cell. See Figure 8. This gives the highly effective action so envied by engineers.

Processing

It is perhaps the processing that goes on between the input and output that will make the most dramatic contribution to the developments in bionics and space exploration. For example one of the characteristics of artificial intelligence is its ability to 'learn' by experience. In machines or robots for exploration this might mean that the device could learn to find its way around an unmapped terrain. In artificial limb research, investigation is underway into using artificial intelligence to turn around completely the conventional approach in which the user has to learn to control the upper arm muscles in order to cause tiny (microvolt) signals to appear on the skin surface as a consequence of muscle activity. Electrodes pick up these signals and are used to trigger motors and gear systems in the replacement limb. For the artificial intelligence approach the limb would 'learn' what the user wanted to do and use the muscle voltage signals detected on the skin surface accordingly, directing the signals to the appropriate actuator. It can easily be seen how this is a much more natural approach, in some ways mimicking how a infant learns to use its new limbs by a sophisticated trial and error routine.

Even the seemingly most simple tasks can benefit from the inclusion of a degree of artificial intelligence - detectors that can learn to recognise defective products on a production line for example through pattern recognition techniques, or machines that can find their own way around a factory, transporting materials. The ultimate processing goal will be to develop devices that exhibit autonomous behaviour. These devices will not only learn from their 'experiences' but will also be able to react to unknown and expected situations. Exploration of the further reaches of the solar system will require just such systems.

Smart Homes

Slightly more commonplace intelligent systems are the 'house management' systems that monitor environmental conditions. In conjunction with 'smart materials' that can automatically change properties with their changing environment these will make future housing more comfortable yet also more energy efficient. Perhaps the simplest material that qualifies as 'smart' is photochromatic glass that becomes darker the more intense the light to which it is exposed. However, automated systems and networking within the home will allow better control over heating and ventilation, power load and domestic appliance control, for example, and this becomes more and more effective as greater levels of 'intelligence' are included with the system. This will range from straightforward timing operations to computer controlled systems that incorporate artificial intelligence and 'learn' the habits, requirements and lifestyles of the home's inhabitants. Entertainment of course is a growth area particularly with the rise in digital services, and 'intelligent' systems can for example learn viewing habits and monitor upcoming TV programs and hence advise or even automatically set a video recorder to record favourite programmes or programmes on a particular theme of interest. 'Cutting edge' (and inevitably controversial) architects have even designed homes that take biomimicry almost to the limit. One example is a home

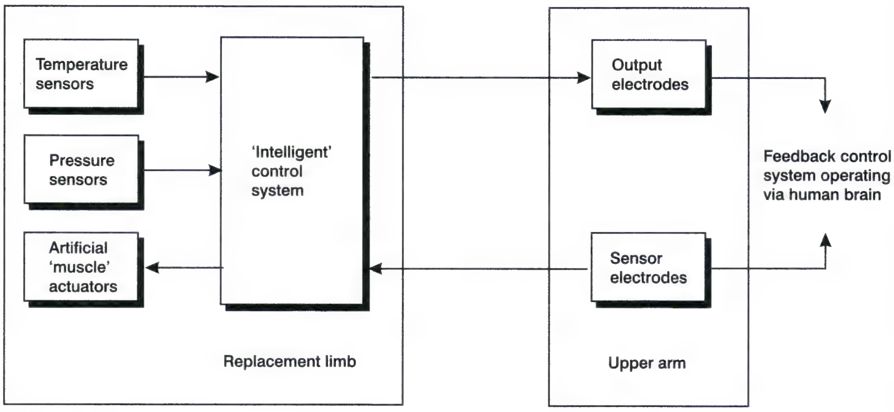

Temperature sensors
Pressure sensors
Artificial 'muscle' actuators
'Intelligent' control system
Replacement limb
Output electrodes
Sensor electrodes
Upper arm
Feedback control system operating via human brain

Figure 9.

built around rooms having the form of the chambers of the shell of the sea-creature the nautilus, and ventilation openings based on dragonfly wings (see **http://www.stephensonstrategies.com/tips/product_marketing_tips/evolutionary_architecture.html).**

Bionics

As already mentioned, of particular importance here is the development of replacement limbs, and a particularly complex function is that of the hand, a beautifully delicate yet complex and sophisticated tool capable of a huge range of tasks, sensations and movement. The hand has forty-four muscles and twenty-seven bones and even state-of-the art technology cannot yet come remotely close to matching its performance. Future progress may rely on alternatives such as tissue engineering where cells, tissues, bones and even complete structures can be 'grown' in 'bio-reactors'. Artificial muscles may provide part of the answer eventually but as yet, although they can provide equivalent speed and force to living muscle, they cannot match the natural muscle's ability to contract to around 50% of its relaxed length. At the moment artificial muscles can only achieve a change in dimension of around 10%. Nevertheless electro-mechanical devices can provide a great deal. As seen they can be operated from the voltages that appear on the surface of the upper arm due to muscle activity, and as with the Minimal Invasive Surgery robot devices, pressure and temperature sensors can be added to the tips of the 'fingers' and 'thumb'. These generate signals that can be manipulated by a small computer system also contained within the limb to give voltages that appear on electrodes also on the upper arm that stimulate nerves to give the sensation of pressure and heat and cold. This completes the feedback system that allows to some degree the sensitivity of grip and sensation of the living limb. (See Figure 9).

Space Exploration

An interesting space exploration project under development is the Nanorover. This is a small (the prototype is around 20 cm long) four-wheeled device designed to operate on low gravity bodies such as asteroids. It will carry two scientific instruments - a camera capable of 'seeing' in several frequency ranges (including visible light) and a spectrometer for analysing the material in its field of view. It has four wheels each at the end of a strut, and all the wheels and struts are independently operable.

This allows the rover to cope with its positioning needs (i.e. to point its scientific instruments at mineral samples, to keep the centre of gravity low for climbing slopes, and to cope with accidentally flipping over - see Figure 10).

A relevant detail about the control of the rover is that there is a 'low-level' system for the motion control that autonomously deals with controlling the actions of the wheels and struts following high level commands from a remote operator. This demonstrates the latest approach to 'intelligent' robotic systems. There is a 'hierarchy' of function that albeit in a very simple way mimics a living system with a brain in that the lower levels quietly get on with the job of co-ordinating muscles and so on while the higher levels deal with vision for instance, and decision-making. (Detail about the Nanorover can be found at **http://robotics.jpl.nasa.gov/tasks/nrover/nrt_main.html)** A further interesting point is that the Nanorover was intended to carry a wiper arm (used to clean the lenses of the scientific cameras) operated by an electroactive polymer 'muscle'. However it appears that even this lightweight actuator has been abandoned due to weight restrictions. (See http://eis.jpl.nasa.gov/ndeaa/nasa-nde/lommas/aa-hp.htm)

The rover for the planned visit to Jupiter's moon Europa will require much more in the way of autonomy, intelligence and decision-making ability than this however. It is generally believed that if there is life anywhere in the solar system it is likely to be in an aqueous environment such as that thought to be present under a layer of ice on Europa. A rover sent in search of this life, having been landed on the icy surface, will need to cut or melt its way through the ice to the ocean below. Isolated from even the delayed contact possible between Europa and the rover's controllers on Earth, it will then need to become a submarine. Using sensors to detect heat and minerals and perhaps organic substances it will need to find its own way to possibly an underwater geyser there - the likely energy source for any such alien life, avoiding extremes of heat and pressure - to find who knows what?

Conclusion

During the last century the disciplines of engineering and life sciences were seen as almost mutually exclusive, except in a few specialised areas of medical research. Under the umbrella titles of biomimetics and artificial life these fields are now working together in a way that should provide enormous benefit both in terms of what is possible and the effectiveness and efficiency of the processes.

Ultimately this might include the possibility of routinely incorporating these devices into the human body for replacement or even improvement of normal body function. Less attractively perhaps these might be the first steps towards the distant future realisation of that much used and abused stalwart of science fiction and fantasy the android. Wherever it leads, and some argue it is not the job of science to worry about where its discoveries might end, this is a fascinating area of much groundbreaking scientific work.

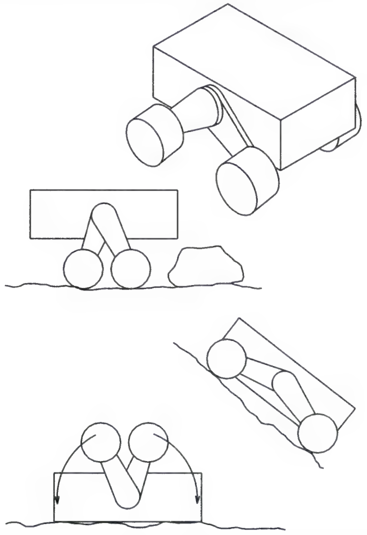
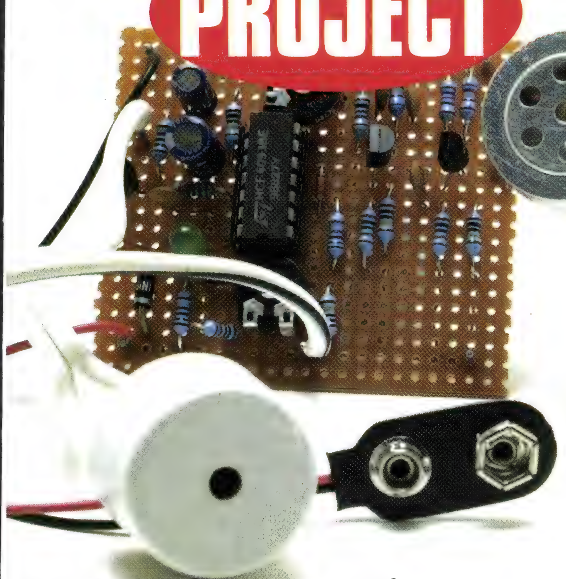


Figure 10.



Telephone ALERT

Gavin Cheeseman describes a versatile 'add-on' to your telephone that lets you know the telephone is ringing when you're in the garden..

Introduction

The idea for this project came when working out in the garden during a recent spell of warm weather. I thought, it would be possible to hear the telephone ringing from the garden even though it was at the other end of the house. Of course, I didn't allow for the cacophony of noise from passing cars, aircraft, lawnmowers, wildlife etc present in the suburban environment. In the dead of night, the sound of my telephone ringing in the house would be as clear as a bell from the garden (pardon the pun) but at any other time, hearing the phone is almost impossible. As a result, I later found I had missed a number of important calls. The simple project described in this article is designed to detect the sound of a telephone ringing, switching on a remotely wired buzzer. The circuit also provides an optical indication.

There are several ways to detect the ringing sound from a telephone. Of course you could use a microphone and a simple audio amplifier to pipe the sound of your telephone around the house but unless carefully arranged, such an arrangement could also relay conversations in the room where the phone is located for everyone to hear. Also, the quiescent current drain of an audio amplifier can be relatively high calling for the provision of a fixed power supply. For these reasons, the use of a buzzer controlled by the sound of the telephone is probably a more suitable option.

In order to trigger the buzzer, it is necessary to detect the ringing sound of the telephone whilst, so far as possible, filtering out other sounds in the ambient environment. A phase locked loop may be used. This responds to frequencies within a limited range. The phase locked loop is tuned to respond to the frequency produced when the telephone rings. Sounds at other frequencies are ignored. This system can be quite effective when correctly set up but does have its problems. Of course, with the wide range of different telephones available these days there can be considerable variation in the type and frequency of the ringing sound produced. One point that may not be immediately obvious is that the ringing sound often consists of more than one frequency and may not be continuous. This can complicate circuit design considerably.

Another way to approach the problem is to use a circuit that switches on the buzzer when the sound level exceeds a specific value. This can work quite well if the detector circuit is placed in close proximity to the telephone and is not too sensitive. Excess sensitivity results in the buzzer sounding when other loud noises are detected in the room. The design described here is based on this concept with some additional circuitry to reduce the degree of false triggering.

Figure 1 shows the block diagram. Sounds picked up by a microphone are initially amplified and fed to a voltage level detector. When the sound level exceeds a specific value, the output of the circuit momentarily changes state. The arrangement is such that in standby condition, the circuit will only respond to sounds that exceed the switching threshold for a given time. Shorter, transient high level sounds are ignored. The sound of the telephone ringing is long enough to activate the circuit. Once activated the output switches state in time with the telephone ringing. A simple transistor switch is used to drive the output buzzer. One small drawback of using this type of circuit is that it does not respond to the first ring but in practice this does not usually present a problem.

Circuit description

The circuit is effectively a mixture of analogue and digital technologies. The circuit diagram is shown in Figure 2. The power supply is connected between terminals P1 (+V) and P2 (0V). Capacitor C6 helps to de-couple any high frequency noise from the power supply rail and C8 provides a degree of filtering close to the output switching stage. Ambient sounds are detected by a crystal microphone connected between terminals P3 and P4. A crystal microphone was chosen as it provides a relatively high output level into a high impedance. The signal from the microphone is amplified by a two-stage transistor amplifier comprising Darlington transistors TR1 and TR2. The Darlington transistor is well suited to low current operation, as it only requires a relatively small base current when compared to a single bipolar transistor. It can be

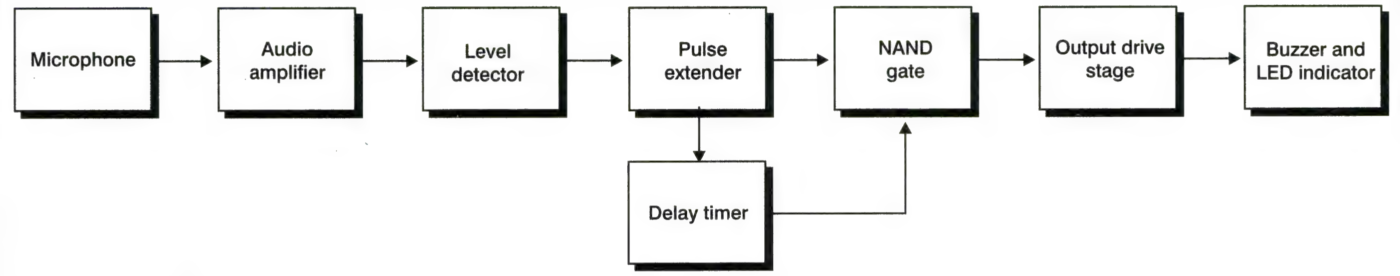


Figure 1. Simplified block diagram.

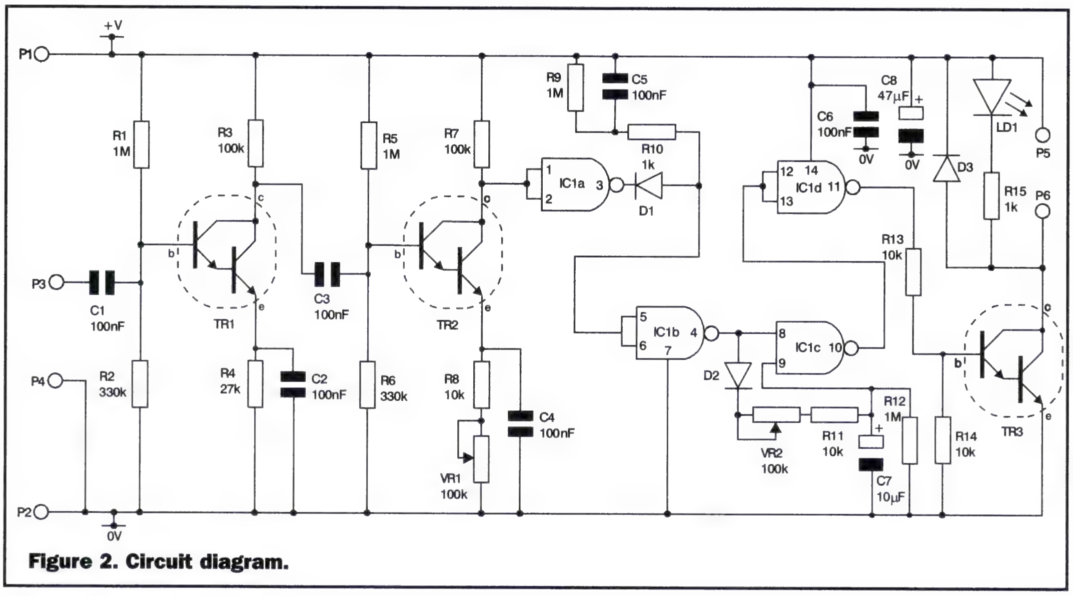


Figure 2. Circuit diagram.

seen that both stages are somewhat similar. Resistors R1, 2, 5 and 6 are bias resistors. Interstage coupling is performed by capacitor C3. Variable resistor VR1 allows the quiescent DC level at the collector of TR2 to be adjusted affecting the final sensitivity of the circuit. The amplified audio signal is fed to the input of IC1a, a quad 2 input Schmitt NAND gate IC. This device operates in the same way as a standard NAND gate but features a degree of hysteresis. As a result, the switching action is clean and predictable. In normal operation, the DC level at the input of IC1a sits below the switching threshold of the IC and only traverses above the threshold when a high level audio signal is present. Consequently, the output at IC1 pin 3 remains in a logic high condition when no sound is present. D1 R9, R10 and C5 form a simple 'charge pump' circuit. This acts as a kind of pulse extender. If a sound of sufficient volume is detected by the microphone, the level at the input of IC1a rises above the switching threshold on audio peaks resulting in pin 3 momentarily switching low. When pin 3 switches low, diode D1 is forward biased rapidly charging C5. In between audio peaks the output of IC1a switches back to the logic high state. This reverse biases D1, preventing C5 from discharging via IC1a. The capacitor still discharges but at a slower rate via R9. The output of the charge pump circuit is connected to IC1b. As with IC1a the inputs of the gate are connected together forming a simple Schmitt inverter. The high impedance inputs of the CMOS device are ideal as they present very little load on the preceding circuit. The output of IC1b is connected directly to one input of IC1c (pin 8) and also to a second charge pump circuit comprising D2, VR2, R11, R12 and C7. The output of the charge pump is connected to the other input of IC1c on pin 9. The time taken to charge capacitor C7 is controlled by VR2. It is important to note that although the configuration of the charge pump circuits are similar, the charge and discharge times of the second circuit are considerably longer. Because IC1c is a NAND gate, pin 10 will only switch to logic low when both inputs are in a logic high condition. High level sounds of short duration such as a hand clap result in IC1 pin 4 momentarily switching high; however, if the duration is not long enough to charge C7 to the appropriate switching threshold, the output of IC1c will remain high. Sounds of a duration long enough to charge C7 to a voltage exceeding the switching threshold result in a low condition on IC1 pin 10. The output remains in this state as long as both of the gate inputs are high. Once charged, C7 holds IC1 pin 9 above the switching threshold for some time after IC1 pin 4 has switched low whereas the level on IC1 pin 8 changes immediately. The overall result is that after the initial period, during which C7 is charging, IC1 pin 10 will switch low with every ring of the telephone. In this state the circuit will also respond to a host of other sounds but this is not generally a problem unless the telephone is sited in a very noisy environment. After the phone stops ringing C7 slowly discharges to a level below the switching threshold of the IC. The output of IC1d is an inverted version of that at IC1c. This results in a high transition on IC1 pin 11 when a telephone ring is detected. The output at pin 11 drives output-switching transistor TR3 and this in turn drives LD1 and any suitable load connected between terminals P5 and P6 (usually a buzzer).

Construction

The circuit may be constructed on matrix board, printed circuit board or any other suitable medium. Although layout is not generally a problem, it should be borne in mind that the transistor amplifier stages exhibit relatively high gain, so the usual rules for laying out audio circuits should be adhered to. Although the aud output is not intended to be listened to, noise pick-up can still present a problem as it ca result in continuous false triggering of the circuit. Therefore all wiring runs shou be kept as short as possible. It is probably a good idea to use separate supply leads for the analogue and digital sections c the circuit joining only at the appropriate supply terminal pins. Capacitor C6 should be positioned in the area of IC1. Additional de-coupling capacito may be connected to the supp line close to TR1 and TR2 if switching noise becomes a problem. However, in most cases this will probably not be necessary. A crystal microphon is used to detect the sound of the telephone ringing. It is recommended that the microphone is connected directly to terminals P3 (signal) and P4 (microphone case) and is not extended. It is better to extend the lead to the output buzzer than extend the microphone lead, as the latter will inevitably result in unwanted noise pickup unless extreme care is taken.

Take care to connect all components correctly when constructing the circuit. This is particularly important with polarised components such as TR1-3, IC1, D1-3, C7 and C8.

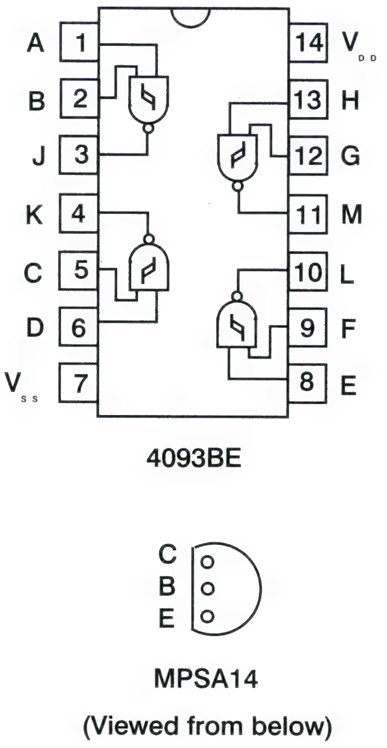


Figure 3. Semiconductor pinout information.

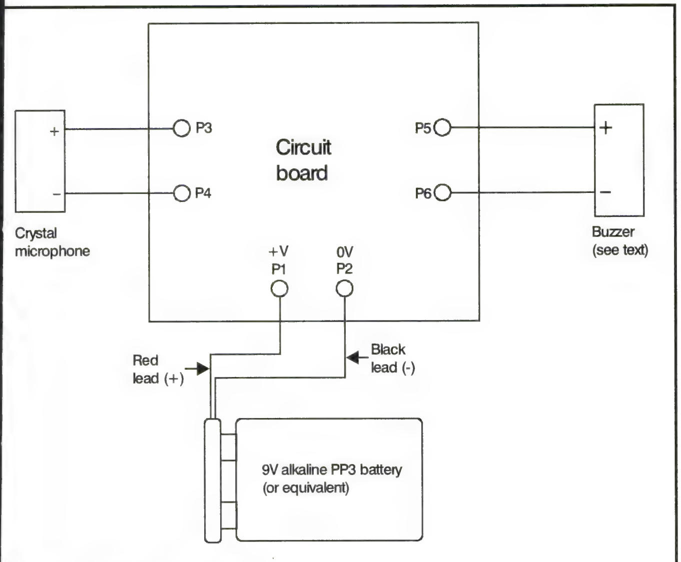


Figure 4. Wiring Diagram.

correct connection of the omponents will result in faulty peration of the circuit and ome components such as the ectrolytic capacitors may even xplode! Figure 3 shows emiconductor pinout nformation. The polarity of lectrolytic capacitors is usually ndicated by markings on the de of the capacitor case. Often negative (-) symbol will be hown adjacent to the negative ead which is also usually horter than the positive lead. If ou are unsure, always double heck before applying power to he circuit. A suitable DIL socket hould be used for IC1 and the C should not be inserted until ll other construction is omplete. CMOS IC's are prone o static damage and the elevant handling precautions hould be taken. Static damage s often insidious and may not esult in immediate failure.

In addition to the components hown on the circuit diagram here are also off-board omponents. It is ecommended that suitable erminal pins are used to onnect off-board components o the circuit board as direct onnections may result in excessive strain on the omponent leads. Figure 4 shows the wiring diagram for the circuit. Light emitting diode LD1 may also be mounted off board if required. Do not use a longer lead than is necessary as this may couple unnecessary noise onto the supply rail. The use of very long leads for the output connections (exceeding a few metres) is not recommended. The buzzer should not be mounted in close proximity to the microphone. If the microphone picks up the sound of the buzzer at high level the circuit will tend to latch up.

Unless you are sure where you want to finally position the buzzer, it is probably best to make a temporary connection using a couple of metres of hook-up or loudspeaker wire to allow the circuit to be tested. In fact the basic operation of the circuit can be tested using just the LED if required. Take care to observe the correct polarity when connecting the buzzer.

The battery clip is soldered to terminals P1 (red lead) and P2 (black lead). Please ensure that the correct polarity is observed as reverse connection of the power supply may result in irreparable damage to the circuit. Do not connect the battery until you are ready to test the unit.

Testing

The circuit is relatively simple to test and no special equipment is required to complete the basic procedure. If available, it may be useful to connect a multimeter set to read current in series with the positive battery lead, to allow current levels to be monitored. Similarly if you have access to an oscilloscope, you can check the correct operation of each stage of the circuit. It is sensible to use a x10 oscilloscope probe as some parts of the circuit are very high impedance and are easily loaded. If you do not have access to the above equipment, this is not a problem. The general operation of the circuit can be checked without any test gear.

Before applying power to the circuit double check your work to ensure that all components are correctly connected. Pay particular attention to the soldering, looking out for any dry joints or solder short circuits. When you are happy that everything appears OK, set VR1 to the minimum resistance position and VR2 to maximum resistance. Connect a suitable alkaline 9V PP3 type battery to the battery clip. In standby condition, the supply current should not exceed a few hundred microamps. If the output buzzer is connected, make sure that it is positioned as far away from the circuit board and microphone as possible. If you have not connected the buzzer, LD1 can be used to indicate the output state of the circuit (a quieter option). Clap your hands once, loudly within a few cm of the microphone (do not touch the microphone as this may result in the circuit picking up mains hum). The circuit should not respond. LD1 and the buzzer should remain off. If you whistle into the microphone or make other sounds of longer duration this should trigger the circuit after a short delay. Once the circuit has been triggered, it should respond almost instantly to any high level sound in close proximity. Allow a few seconds of silence for the circuit to reset and try the same test a second time. Once again the circuit should become insensitive to single short duration sounds such as a hand clap but sounds of longer duration should switch on LD1 and the buzzer. General background noise in the room, unless very loud, should not trigger the circuit.

Adjusting VR1 should change the effective sensitivity of the unit. Monitoring the quiescent voltage level at the collector of TR2, clearly shows the effect of varying the preset control. As the resistance of VR1 is increased, the DC voltage level at the transistor's collector also increases. As a result the circuit responds to lower level audio signals until, past a certain point, the output circuit is permanently switched on. It should be noted that although adjusting VR1 creates the effect of varying the sensitivity of the unit, the gain of the transistor stage is comparatively unchanged at high frequencies. This is because the emitter resistance is effectively bypassed by capacitor C4. In practice, the effect of varying VR1 on sensitivity is relatively subtle.

The setting of VR2 determines the delay time before the circuit will respond to a telephone ringing. The preset resistor controls the time taken to charge C7. Setting VR2 to a lower resistance position will result in the circuit responding more quickly. However, in practice this will also make the unit more prone to false triggering particularly in a noisier environment. Conversely, setting VR2 to maximum resistance means that the circuit may miss the first couple of rings. The most appropriate setting is probably best determined empirically.

Check the operation of the circuit with the controls set to various positions to ensure that they produce the appropriate effect. Once testing is complete the circuit may be installed into a suitable housing. Almost any suitable plastic case may be used. Holes should be drilled for external wiring and close to the position of the microphone to allow sound to enter.

Using the Telephone Alert

How and where the circuit is used is very much dictated by individual circumstances. The housed circuit board together with the attached microphone needs to be positioned as close as possible to, but not in contact with the telephone so that the sound of the telephone

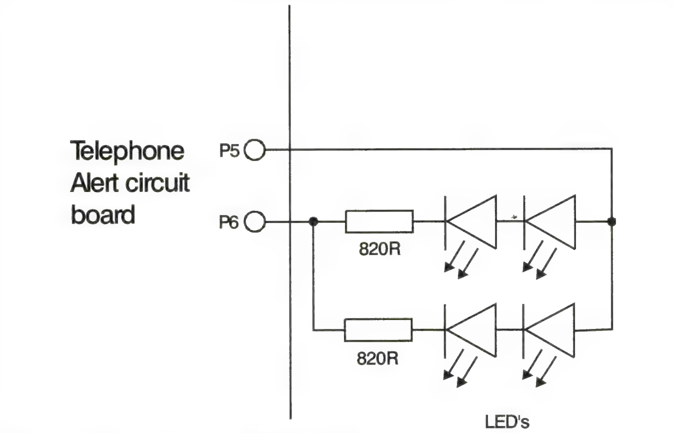


Figure 5. Connecting additional LEDs.

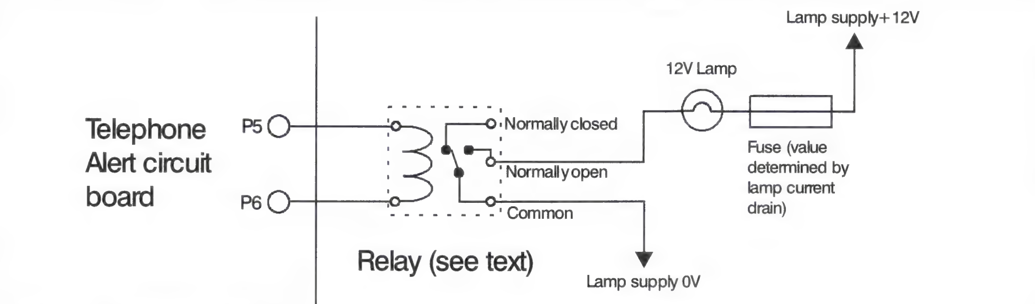


Figure 6. Switching a relay.

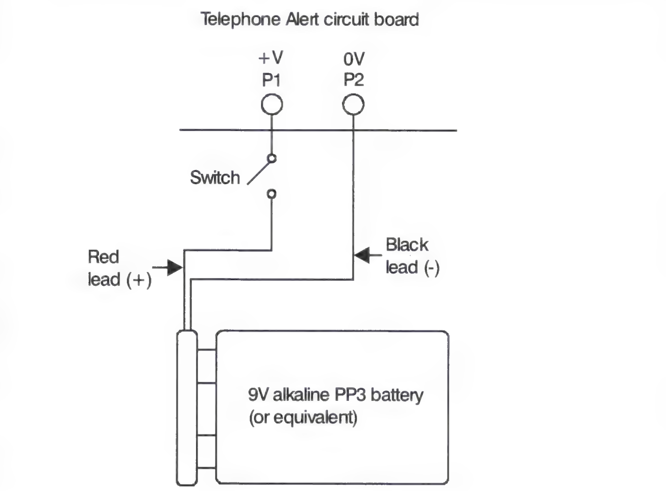

Telephone Alert circuit board
+V
P1
0V
P2
Switch
Red lead (+)
Black lead (-)
9V alkaline PP3 battery (or equivalent)

Figure 7. Fitting a power on/off switch.

ringing is as loud as possible. It is best if the telephone is loud enough to trigger the circuit when it is adjusted to the most insensitive setting as this helps to minimise unwanted false triggering. The buzzer would normally be wired off to a remote location (another room, garden shed etc). It should be pointed out that the buzzer is not waterproof and so should not be mounted in a location where it is likely to be exposed to the elements.

If required, a number of LED's may be connected to create a more visible optical indication. This may be useful in noisy situations where it is not possible to hear the buzzer, for example when operating power tools, wearing headphones etc. Figure 5 shows an example of how to connect additional LEDs. Low current LEDs provide good performance.

The output may also be used to switch other small loads such as a suitable relay. An example of how to do this is shown in Figure 6 for reference although in practice arrangements may vary. It is recommended that the output (coil) current is limited to 100mA maximum to avoid damage to TR3. The relay may then be used to switch a higher current load such as a light bulb. A separate supply would be required for the load connected to the relay contacts and suitable fusing must be used. For safety reasons it is recommended that only low voltage supplies (less than 50V) are switched via the relay contacts using this arrangement. In the example 12V DC is used.

Battery life varies depending how often the circuit is triggered. The battery will last longer in an environment where the phone rings only occasionally. Connecting additional loads to the output will tend to reduce battery life. If necessary, a power on/off switch may be connected in series with the positive battery lead to allow the unit to be switched off when it is not needed. Figure 7 shows how to fit an on/off switch.

False triggering

In most cases the unit should perform well without any problem. However, because of the simplicity of the circuit, false triggering may be experienced under some conditions. Loud noises other than the telephone may sometimes trigger the unit. The occasional beep sound from the buzzer is not generally a problem as the repetitive ringing sound of the telephone is clearly recognisable. Longer beeps may, however be annoying. It may be useful to increase the delay before the circuit responds by increasing the value of R11. Removing C2 should reduce the gain of the input circuit at audio frequencies making it less sensitive. However it should be pointed out that if the background noise in the room where the telephone is located is continuously louder than the phone, the circuit will simply latch on permanently.

The circuit may also be false triggered by strong RF fields and in some cases it may be necessary to add additional filter components or screening to the unit to prevent this. Radio frequencies are typically be picked up on external leads. The problem can be reduced using simple ferrite choke or bead arrangements as illustrated in Figure 8. The output leads are shown in the diagram but a similar arrangement can be used on the other external leads if required.

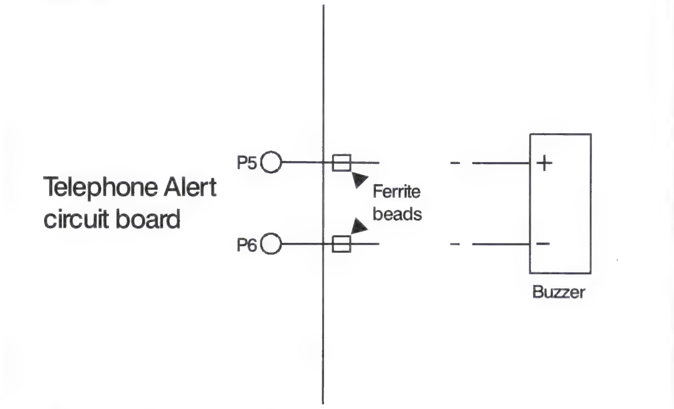
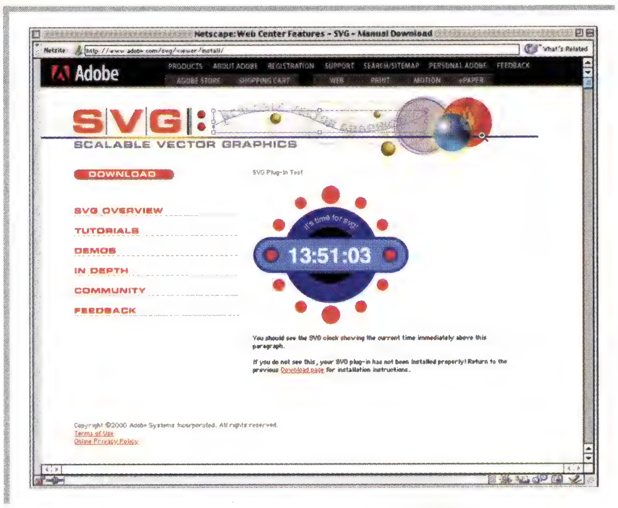


Figure 8. Using ferrite beads to reduce the effects of RF pickup by the output lead.

PROJECT PARTS LIST

RESISTORS: All 0·5W 5% Metal Film (Unless Stated)			
R1, 5, 9, 12	1M	4	M1M
R2, 6	330k	2	M330K
R3, 7	100k	2	M100K
R4	27k	1	M27K
R8, 11, 13, 14	10k	4	M10K
R10, 15	1k	2	M1K
VR1, 2	Hor Encl Preset 100k	2	UH06G
CAPACITORS			
C1-6	Minidisc 0.1μF 16V	6	YR75S
C7	GenElect 10μF 63V	1	AT77J
C8	GenElect 47μF16V	1	AT39N
SEMICONDUCTORS			
D1, 2	1N4148	2	QL80B
D3	1N4002	1	QL74R
TR1-3	MPSA14	3	QH60Q
IC1	4093BE	1	QW53H
LD1	LED Green	1	WL28F
MISCELLANEOUS			
	DIL Socket 14-Pin	1	BL18U
	Pin 2145	6 Pins	FL24B
	PP3 Clip	1	HF28F
	Crystal Mic In Metal	1	HY33L
	DC Piezo Buzzer	1	KU56L



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SVG

SVG stands for scalable vector graphics, a brand-new form of image creation language that's tailored for Web pages. Based on the same principles that make PostScript graphic images so popular - the ability to allow re-sizing of images without losing graphical clarity, while maintaining a small file size - SVG looks set to become an instant hit with Web page creators worldwide.

The SVG language has been developed by the World Wide Web Consortium (W3C) and its members, who include numerous technology industry leaders like Adobe, Apple, Corel, Hewlett-Packard, IBM, Kodak, Macromedia, Microsoft, Netscape Communications, Quark, Sun Microsystems, and Xerox. It has been designed as an open language, and actually describes two-dimensional graphic images using Extensible Markup Language (XML), the technology destined to replace the currently more usual HTML method of creating Web pages. Because it expresses vector graphics in XML and is compatible with other related W3C initiatives, SVG's impact is expected to be profound. For example, SVG meets the challenge of e-commerce Website problems by solving several complex design issues.

Currently the language is in its final draft stages but SVG images are already being used in Websites, and all that users need to view the images is a plug-in viewer in their Web browser. Viewers are available for both Windows and Macintosh versions of Microsoft Internet Explorer and Netscape Navigator. Only recent versions of the Web browsers are compatible, as they are required to view XML pages anyway, and currently only static SVG images are viewable in the Macintosh version of Microsoft Internet Explorer.

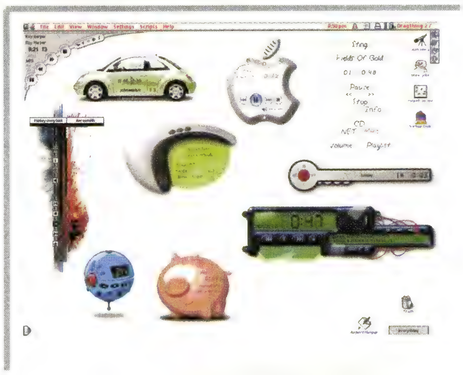
The SVG Viewer can be downloaded from Adobe's Website, at: **<http://www.adobe.com/svg/viewer/install/>**, but it is also bundled in the latest release of Adobe's best-selling illustration application Illustrator (version 9.0), and will be included in forthcoming versions of other illustration applications.

The World Wide Web Consortium has detailed information about SVG, on its Website, at: **< www.w3.org/ Graphics/SVG >**, and the Adobe Website has links to several example pages which feature SVG graphical images.

Mac Music Maker

Panic Software has recently released version 1.5 of its high-quality mp3/CD audio player for Macintosh computers. Audion uses playlists to store favourite track ordering, and playlists are as easy to use as dragging tracks into and out, with deep playlists - folder-based hierarchies of music - and full CDDB (CD database) support across the Internet for track and album checking and listing.

But all these features and quality is not Audion's most rewarding ability. Like many music players these days, Audion support the use of different appearances - called skins by some payers, but known as faces in Audion. And Audion has some of the best around, and certainly a very wide selection.

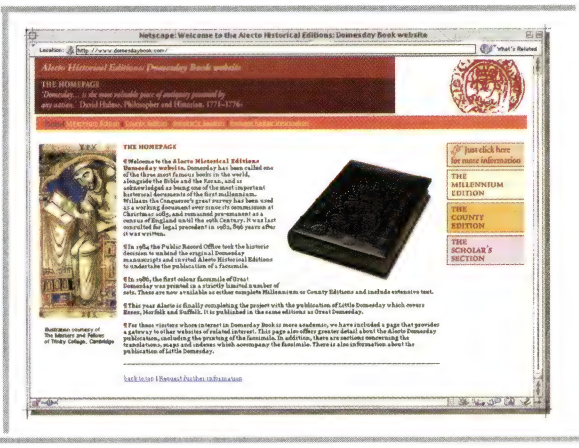


Aerial Reception

The whole country is being photographed from the air, in an ambitious project called the Millennium Map, which allows you to locate anywhere that's been mapped and purchase the photograph and other details about the area. The Website, GetMapping, at: **<http://www.getmapping.com>** isn't quite complete yet, but many places (over half the country at a guess) are already online, and the others will be following shortly. You can enter location details by name or preferably by postcode, and roam around the area until you get the view you want for your photograph. A downloadable plug-in for your Web browser also allows zooming in and out of the photograph (although we couldn't actually find a link to download it when we tried).

The project started in April 1999, and four Rockwell Aerocommander aircraft, complete with computer-controlled camera equipment to the value of £250,000, have since been systematically flying the length and breadth of the country. Detail of the photographs allows objects of a minimum size of 25cm to be seen. Around 90% of England has been photographed, and Scotland and Wales will be done so after England has been completed. To date, over 56,000 photographs have been taken on 9-inch film, and each roll of film is 500 foot long. Scanning of each photographic image then takes place, and the final image is map accurate, which means that it can be used in conjunction with conventional 1:10,000 scale maps.

A nice touch is that, when you've located the area you want for your photograph, an option to view the Domesday Book entry for that area takes you to the Domesday Book Website, at: **<http://www.domesdaybook.com>**.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THE HOMEPAGE

'Domesday... is the most valuable piece of antiquity possessed by any nation.' David Hulme, Philosopher and Historian, 1711–1776

THE HOMEPAGE

¶Welcome to the **Alecto Historical Editions Domesday website.** Domesday has been called one of the three most famous books in the world, alongside the Bible and the Koran, and is acknowledged as being one of the most important historical documents of the first millennium. William the Conqueror's great survey has been used as a working document ever since its commission at Christmas 1085, and remained pre-eminent as a census of England until the 19th Century. It was last consulted for legal precedent in 1982, 896 years after it was written.

¶In 1984 the Public Record Office took the historic decision to unbind the original Domesday manuscripts and invited Alecto Historical Editions to undertake the publication of a facsimile.

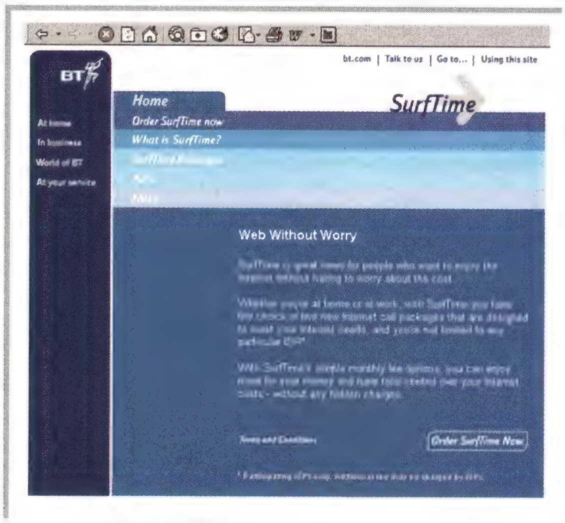
¶In 1986, the first colour facsimile of Great Domesday was printed in a strictly limited number of sets. These are now available as either complete Millennium or County Editions and include extensive text.

¶This year Alecto is finally completing the project with the publication of Little Domesday which covers Essex, Norfolk and Suffolk. It is published in the same editions as Great Domesday.

¶For those visitors whose interest in Domesday Book is more academic, we have included a page that provides a gateway to other websites of related interest. This page also offers greater detail about the Alecto Domesday publication, including the printing of the facsimile. In addition, there are sections concerning the translations, maps and indexes which accompany the facsimile. There is also information about the publication of Little Domesday.

Illustration courtesy of The Masters and Fellows of Trinity College, Cambridge

BT SurfTime Goes Live



SurfTime at **<www.bt.com/surftime>**, gives BT customers unlimited telephone calls to the Internet for a fixed fee. It means that BT customers will be able to subscribe to one or more Internet Service Providers whilst retaining absolute control over the telephone charges they pay.

Two SurfTime options cater for different needs:

- Customers can get unlimited calls to the Internet at weekends and on weekday evenings for £5.99 a month.
- Heavier residential users can get round the clock unlimited calls to the Internet for £19.99 a month.

But significantly, BT's SurfTime will provide access to all Internet Service Providers that offer service on the 0844 04 telephone number range. ISPs are likely to make further charges for the use of their services, and BT will provide optional billing services to ISPs.

ISPs who have already announced that they will provide access via the 0844 04 SurfTime number include: Affinity Internet Holdings, BT Internet, BT Click for Business, Freeserve and PlusNet .

America Online Unveils AOLTV

AOL at **<www.aol.com>** has launched the AOLTV service, that it believes will fundamentally transform the Internet television experience.

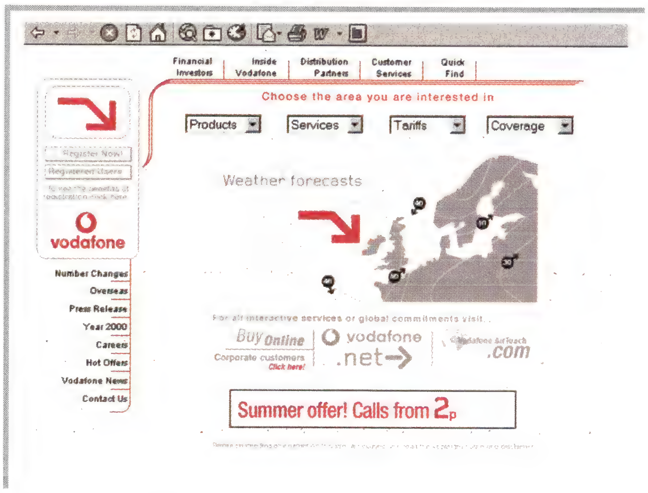
AOLTV combines television with the Internet to allow AOL members and other consumers to take advantages of convenient AOL features like e-mail, instant messaging, and chat with AOL's worldwide community of nearly 23 million members - at the same time that they watch their favourite television shows.

AOLTV enhances the TV experience by:

- Giving consumers access to familiar, convenient AOL features and AOL's worldwide community of nearly 23 million members.
- Responding to viewer demand for an easier way to choose programs from the hundreds of available channels with the AOLTV Program Guide - an easy-to-use menu that organises channels by category and provides brief descriptions of three days worth of shows.
- Creating a new platform for broadcasters and cable networks to provide innovative interactive programming to complement their TV shows - everything from in-depth background accompanying news and sports programming, as well as interactive polls and e-commerce opportunities linked directly to the shows on screen to local information on community-wide events or emergencies.

AOLTV also provides access to AOL's 'You've Got Pictures' feature, allowing members to organise and view their family pictures on the television screen. The AOLTV Program Guide allows users to change channels by clicking on words and graphics, rather than scrolling through channels one by one.

Vodafone Starts Groundbreaking GSM Internet Trial



Vodafone at **<www.vodafone.co.uk>** has commenced trials of GSM on the Internet, a new service for corporate customers which will enable simultaneous voice and data calls using a combination of GSM technology and Internet Protocol.

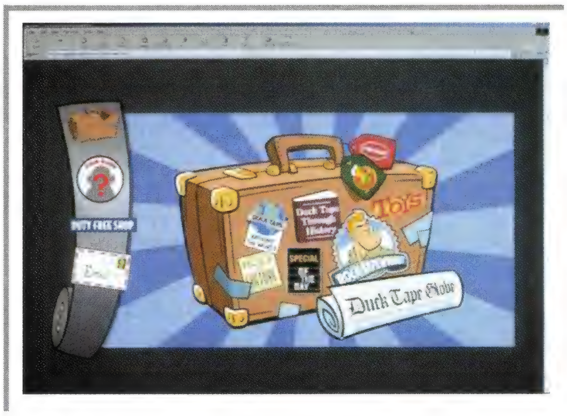
Developed by Ericsson, it is the first version to support multi-network connectivity, which allows voice calls to and from a range of internal and external networks, and also the first version to support the use of a PC.

GSM on the Internet will offer customers the ability to access IP-based applications whilst on a voice call, via the new generation of mobile devices or a PC. Applications could include internal and external databases, company intranets, personal information management applications (such as Microsoft Outlook) and the Internet.

For example, when a voice call is received from a customer, account details for that customer could be sent automatically from an intranet database to the receiving PC or mobile device and viewed simultaneously with the voice call. Two-way data transmission will enable, for example, electronic invoices to be signed, issued and returned in real time whilst both parties are still on the original call.

Trials of GSM on the Internet are currently taking place at Vodafone's headquarters in Newbury, Berkshire. Further development and customer trials will take place before the launched version - compatible with WAP and GPRS - will be commercially available at the end of next year.

Web Surfers Stuck on Duck Tape Web Site



Can you believe it? A Web site dedicated to duck tape. No April Fools day is long gone. Web surfers are truly getting stuck on a Web site devoted to duck tape.

The press release claims that the site at **<www.ducktapeclub.com>** inspires visitors with animated characters, sound effects and content as it spreads the duck tape story to diehard fans and those who are newly converted to its uses. What next?

WowRing.com Portal for Free Long-Distance Calls

WowRing.com has announced the launch of its 'Web-to-phone' portal that will allow Internet users anywhere in the world to make free long-distance phone calls.

The service, which is supported by advertising, is now available free to anyone who completes a simple registration form at **<www.wowring.com>**.

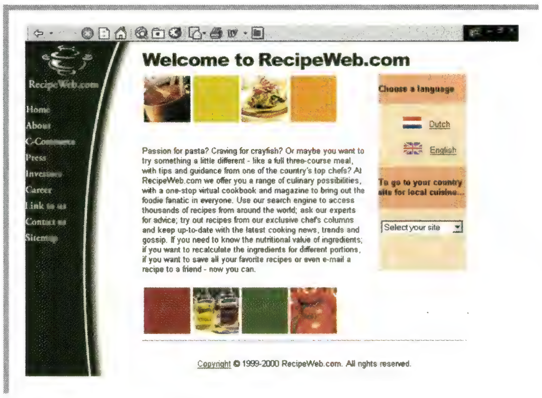
A recent study by International Data Corporation (IDC) shows that 'voice-over-IP' (VoIP) traffic is tripling on an annual basis, compared to 12% to 16% yearly increases in traffic over conventional phone networks.

After a user registers at the WowRing.com site, a keypad will appear on the screen. Callers enter the telephone number simply by clicking on the numbers on the keypad or by entering the number directly from their keyboard.

Each time a registered user visits WowRing.com to make a call, the site automatically checks the user's system for the latest version of the keypad. If a new one is available, it is downloaded automatically.

Customer support is available directly from the WowRing.com site, which offers a comprehensive 'frequently asked questions' (FAQ) section and a tutorial on how to make calls.

Recipeweb is a Melting Pot for the Kitchen



Welcome to RecipeWeb.com

Passion for pasta? Craving for crayfish? Or maybe you want to try something a little different - like a full three-course meal, with tips and guidance from one of the country's top chefs? At RecipeWeb.com we offer you a range of culinary possibilities, with a one-stop virtual cookbook and magazine to bring out the foodie fanatic in everyone. Use our search engine to access thousands of recipes from around the world; ask our experts for advice; try out recipes from our exclusive chef's columns and keep up-to-date with the latest cooking news, trends and gossip. If you need to know the nutritional value of ingredients; if you want to recalculate the ingredients for different portions, if you want to save all your favorite recipes or even e-mail a recipe to a friend - now you can.

Copyright © 1999-2000 RecipeWeb.com. All rights reserved.

Tired of the same old recipes? Worried about the long term affect of your diet but don't know how to improve it? Now there is a Web site that could see a change in the way you eat forever.

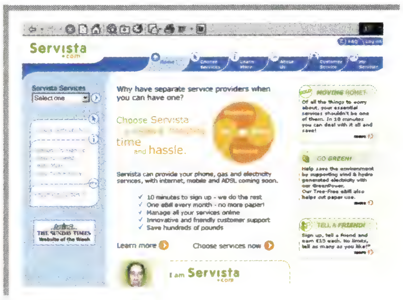
RecipeWeb.co.uk at **<www.recipeweb.co.uk>**, the UK's first specialist on-line source of recipes, related features and culinary and nutrition advice.

Eliminating the need to wade through endless cookbooks to find the dish you crave, RecipeWeb.co.uk gives you all the information you need at the touch of a key.

All the recipes on the site are accredited to leading chefs and nutritionists such as Anton Edelmann of The Savoy, Richard Coates of The Belgo Group and Thane Prince, the renowned culinary writer.

RecipeWeb.co.uk has the answer whether you're looking to prepare a quick snack or a dinner party for twelve. You can currently search by ingredient, cooking time, cuisine and experience - appealing to the culinary expert and the kitchen novice alike. The site will also soon offer the ability to search by calorie content for those looking to watch their weight.

Save £152 on Household Bills in Just Ten Minutes



Why have separate service providers when you can have one?

Servista can provide your phone, gas and electricity services, with internet, mobile and ADSL coming soon.

- ✓ 10 minutes to sign up - we do the rest
- ✓ One eBill every month - no more paper!
- ✓ Manage all your services online
- ✓ Innovative and friendly customer support
- ✓ Save hundreds of pounds

Of all the things to worry about, your essential services shouldn't be one of them. In 10 minutes you can deal with it all and save!

Help save the environment by supporting wind & hydro generated electricity with our GreenPower. Our Tree-Free eBill also helps cut paper use.

Sign up, tell a friend and earn £15 each. No limits, tell as many as you like!

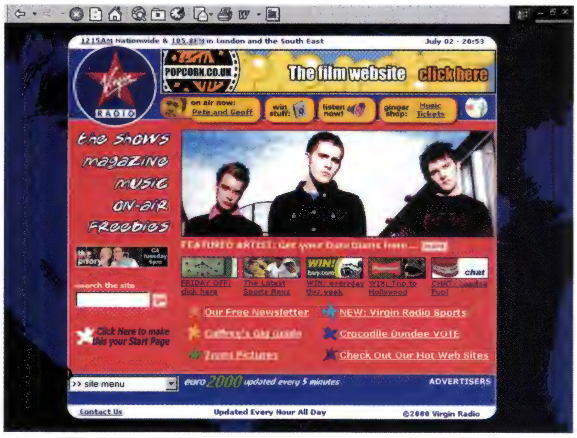
When it comes to gas bills alone, research shows that: half the population know they can change their gas supplier but less than one in four have actually switched; and 5.5 million adults do not know whether or not they are paying too much.

Servista.com at **<www.servista.com>** promises to save the average household £152 a year on their combined phone, electricity and gas bills. The company is Britain's first Internet-based provider of telecoms, gas and electricity and is the first to introduce a single eBill for however many domestic services.

Thanks to open competition, Servista's formula brings home the benefits of deregulation to consumers as intended by the government's regulatory bodies. Until now, consumers have known they can save money by switching service provider, but less than one in four have switched because it is such a hassle.

Now, consumers can save money by switching one or all of their essential services to Servista in just ten minutes. The company aims to save millions of UK households hundreds of pounds, and Servista's combined eBill for telecoms, gas and electricity aims to cut out both the hassle of receiving separate bills, and the time wasted having to manage relationships with separate service providers through unhelpful call centres.

Zoom in for a Closer Look



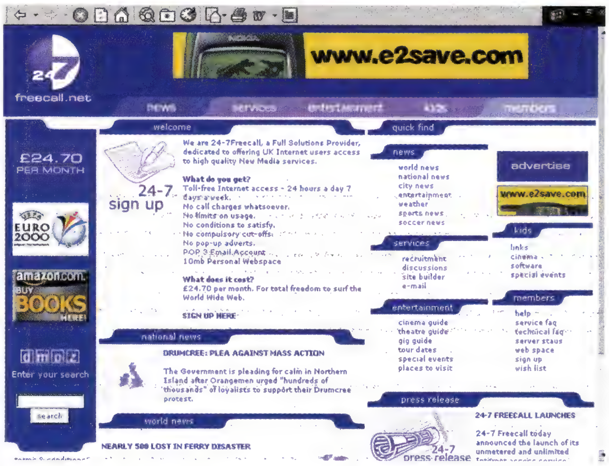
Ginger Online has introduced MGI ZOOM technology on its three Web sites **<www.virginradio.co.uk>**, **<www.theprioryshow.com>** and **<www.tfifriday.com>**, which will allow fans of the radio and TV shows to zoom in for a closer look at their favourite moments and take virtual tours around the studios.

Ginger Online's most popular site, **<www.virginradio.co.uk>**, includes 'zoomable' pictures of Chris Evans and his Breakfast Show Team in action, together with a fully navigational, zoomable virtual tour of the studio created in conjunction with MGI's 360° panoramic software, PhotoVista.

On The Priory Show's Web site, the viewer can take a close-up peak behind the scenes of the hit series, nose around on Jamie Theakston's desk, zoom in on Zoe Ball interviewing top guests, and even spy on the audience.

TFIFriday online shows photos of Supergrass and other major artists on stage, plus a virtual panoramic tour of the studio, with 'hotspots' that automatically transport you into different rooms and locations.

24-7 Freecall Offers Unmetered Internet Access



We are 24-7Freecall, a Full Solutions Provider, dedicated to offering UK Internet users access to high quality New Media services.

What do you get?
Toll-free Internet access - 24 hours a day 7 days a week.
No call charges whatsoever.
No limits on usage.
No conditions to satisfy.
No compulsory cut-offs.
No pop-up adverts.
POP 3 Email Account
10mb Personal Webspace

What does it cost?
£24.70 per month. For total freedom to surf the World Wide Web.

SIGN UP HERE

DRUMCREE: PLEA AGAINST MASS ACTION

The Government is pleading for calm in Northern Island after Orangemen urged "hundreds of thousands" of loyalists to support their Drumcree protest.

NEARLY 500 LOST IN FERRY DISASTER

24-7 FREECALL LAUNCHES

24-7 Freecall today announced the launch of its unmetered and unlimited

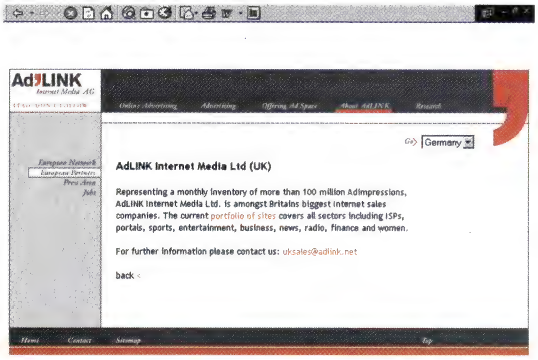
24-7 Freecall at **<www.24-7freecall.net>** has announced the launch of its unmetered and unlimited Internet access service. The cost is a flat rate charge of £24.70 per month with no contracts to sign, or set up costs incurred.

The service is based on quality and value for money, and will initially only be available to a limited number of users who are looking for a reliable service that is unhindered by restrictions and conditions. 24-7 Freecall also plans to offer a range of services such as WAP and ADSL.

Contention Ratios, the number of users who can simultaneously use the same modem line to access the Internet, average 65/1 in the UK with many Internet Service Providers (ISPs) operating at a much higher level.

24-7 Freecall is offering one of Europe's lowest contention ratios which means that users will have no difficulty in assessing the service even during busy times of the day.

Death of Internet Banner Advertising Exaggerated



AdLINK Internet Media Ltd (UK)

Representing a monthly inventory of more than 100 million AdImpressions, AdLINK Internet Media Ltd. is amongst Britains biggest internet sales companies. The current portfolio of sites covers all sectors including ISPs, portals, sports, entertainment, business, news, radio, finance and women.

For further information please contact us: uksales@adlink.net

back <

In spite of their comparatively small share of the total advertising market, Internet banners adverts do convey brand and content very clearly to Internet users - and just under half of online consumers believe that banner advertising is the advertising medium of the future.

These are just some of the key findings of the Banner Brand Impact Study undertaken in five European countries by **<icon-webmax.com>** GmbH on behalf leading of AdLINK Internet Media at **<www.adlink.de>**, Europe's leading independent Internet advertising network.

In this primary study, 500 online users from the UK, Germany, France, Sweden and Spain were interviewed in person and asked to assess the advertising impact of a variety of Internet banners. Two banners from nationally known branded companies were tested in each country, selected from the following industries: automotive, travel, information technology and information services.

In addition a single, uniform banner from the automotive sector was tested in each country to act as a control mechanism. The study showed that in many cases, banner advertising was perceived as having informational value to Internet users rather than merely trying to sell them something.

This was particularly the case in Germany, where 47% did not regard banner advertising as a pure selling tool. The research also showed that banners are often viewed as a source of information and as a means of accessing the advertiser's Web site.

Between 79% (UK) and 93% (Sweden) of those questioned click through a banner 'occasionally to frequently' because it catches their attention or helps users to obtain additional information. Up to 48% of the Internet users questioned described banner advertising as the advertising medium of the future.

Study Reveals International Internet Communication Breakdown

Rainier Worldwide

Welcome to Rainier, a global PR and advertising agency for technology-focused companies. We're a different kind of agency than you might be used to -- not only do we understand technology, but also its overall business implications.

Rainier designs and executes marketing communications campaigns for companies of all sizes, from start-ups to Fortune 500 and FTSE 250 businesses -- we have worked with numerous clients through IPOs and acquisitions. Our business-to-business and consumer clients focus on markets ranging from deeply embedded real-time systems to datacom, from networking to consumer electronics, and from e-commerce to IT consulting services. Through well-executed positioning and creative branding, we have helped to dramatically increase our clients' visibility and create real market value.

Rainier places results at the heart of its client work. Accounts are always headed by senior-level personnel with

More than 40% of the leading UK and US public companies are failing to take the Web seriously as a communication channel and are not using it as a direct communication medium with customers, investors and other target audiences. Some are even in the precarious position of failing to deliver on promises they make on their sites to customers and investors.

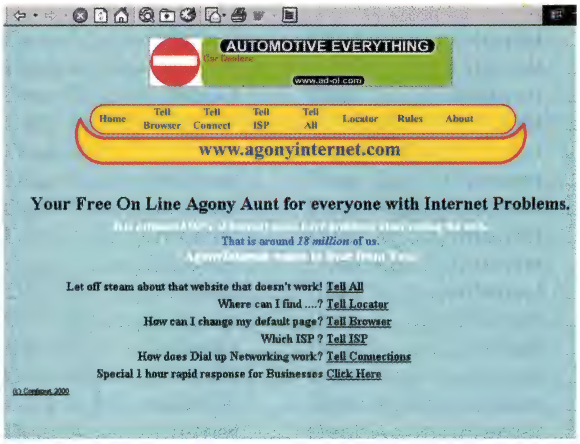
This is the conclusion of the second Rainier Web-Index study into the use of the Web by the FTSE 100 and the top 100 Fortune Rainier at **<www.rainierco.co.uk>**, the international technology marketing communications consultancy. The results demonstrate a clear requirement for large corporates to adjust their global Internet strategies to ensure that their public Web response capabilities are at the very least as effective as telephoning, faxing or writing to their national or international headquarters.

The Rainier Web-Index study found that in Britain only 71 of the FTSE 100 companies could be contacted by e-mail via their Web site and of these more than 20% including, National Grid, P&O and Telewest failed to respond to multiple requests for basic investor information after a wait of three months.

A total of 29 of the FTSE 100 companies including Bass, Marks & Spencer and Thames Water could not be reached by e-mail via their Web site or did not have a Web site.

By comparison, 77 of the Fortune 100 companies in the US could be contacted by e-mail and of these a third, including American Express, Motorola and Walt Disney failed to respond to a request for basic investor information after a wait of three months. Additionally, 23 of the Fortune 100 companies including GTE, Hewlett-Packard and Intel and could not be reached by e-mail via their Web site.

AgonyInternet for Internet Unknown



Your Free On Line Agony Aunt for everyone with Internet Problems.

That is around *18 million* of us.

Let off steam about that website that doesn't work! Tell All

Where can I find ....? Tell Locator

How can I change my default page? Tell Browser

Which ISP ? Tell ISP

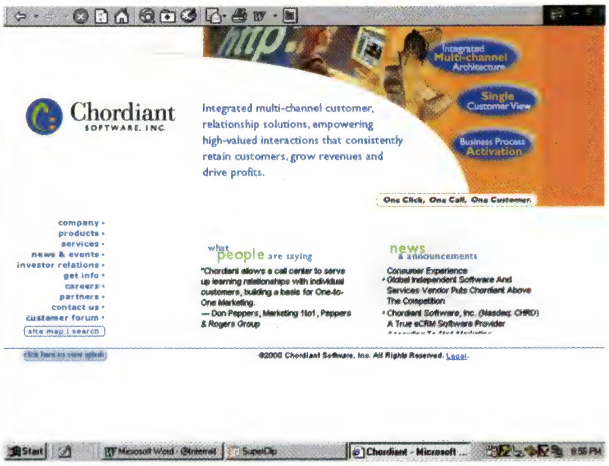
How does Dial up Networking work? Tell Connections

Special 1 hour rapid response for Businesses Click Here

AgonyInternet **<www.agonyinternet.com>** is now on line. The site is a haven for anyone who is unsure about any aspect of the Internet can ask their question and get a no-nonsense reply everyone can understand.

AgonyInternet is a simple site designed for the user to easily browse, find the subject they want, and send a question. Agony Internet replies are usually online within 24 hours, many quicker. And are available for everyone to see.

First-Generation 'Clicks And Mortar' Fail at Customer Service



Integrated multi-channel customer, relationship solutions, empowering high-valued interactions that consistently retain customers, grow revenues and drive profits.

"Chordiant allows a call center to serve up learning relationships with individual customers, building a basis for One-to-One Marketing.
— Don Peppers, Marketing 1to1, Peppers & Rogers Group

Consumer Experience
- Global Independent Software And Services Vendor Puts Chordiant Above The Competition
- Chordiant Software, Inc. (Nasdaq: CHRD) A True eCRM Software Provider

©2000 Chordiant Software, Inc. All Rights Reserved. Legal.

UK blue-chips are more eager to adopt a 'clicks and mortar' strategy than continental counterparts, according to a qualitative survey of 171 British, German and Dutch organisations published in June by Chordiant Software at **<www.chordiant.com>**.

However, of the companies surveyed, the UK had the worst record when it came to sharing customer information between existing departments. The combination of these two factors suggests that the UK is developing e-commerce divisions in technical isolation from existing operations, severely compromising quality and consistency of customer service.

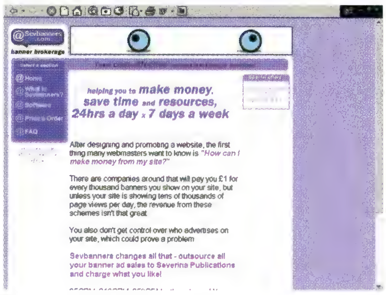
Scoot Gets the Loot

Scoot at **<www.scoot.com>** has acquired Loot at **<www.loot.com>** in a deal worth £189.8 million.

The combined company is set to form the UK's largest market place for buyers and sellers, one unique company where sellers can publish their offer not only in print and on the Internet but also via mobile and fixed line telephones and through digital TV.

The deal will create the largest destination site for classified and directory services in the UK. Scoot's strength in the business to consumer market place and Loot's expertise in the consumer to consumer arena makes a powerful exchange where buyers can find exactly what they need, where they need it, using whatever media they choose.

Money Makes the Web Go Round



helping you to make money, save time and resources, 24hrs a day x 7 days a week

After designing and promoting a website, the first thing many webmasters want to know is *"How can I make money from my site?"*

There are companies around that will pay you £1 for every thousand banners you show on your site, but unless your site is showing tens of thousands of page views per day, the revenue from these schemes isn't that great

You also don't get control over who advertises on your site, which could prove a problem

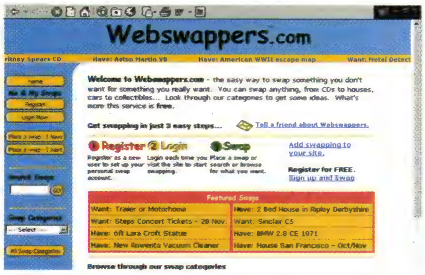
Sevbanners changes all that - outsource all your banner ad sales to Severina Publications and charge what you like!

Sevbanners.com at **<www.sevbanners.com>**, a new service set up by Northants based Internet marketeers, Severina Publications, aims to help small and medium sized business owners make money from their Web traffic by selling banner advertising on their sites.

Sevbanners.com aims to help sites large and small sell their banner advertising, with a dedicated team of telephonists finding the right buyers for the right site.

With companies such as UK Banners at **<www.ukbanners.com>**, Tapaz at **<www.tapaz.com>** and Shoutloud.com at **<www.shoutloud.com>** already signed up, Nikki and her team have sold almost a million banner impressions in the first month of the service, with more to come.

Top of the Swaps - Webswappers 'Swap 10'



Welcome to Webswappers.com - the easy way to swap something you don't want for something you really want. You can swap anything, from CDs to houses, cars to collectibles.... Look through our categories to get some ideas. What's more this service is free.

Get swapping in just 3 easy steps...

Register as a new user to set up your personal swap account.

Login each time you visit the site to start swapping.

Place a swap or search or browse for what you want.

Register for FREE.

Featured Swaps	
Want: Trailer or Motorhome	Have: 2 Bed House in Ripley Derbyshire
Want: Steps Concert Tickets - 28 Nov.	Want: Sinclair C5
Have: 6ft Lara Croft Statue	Have: BMW 2.8 CE 1971
Have: New Rowenta Vacuum Cleaner	Have: House San Francisco - Oct/Nov

Browse through our swap categories

A new report published in June exposes for the first time the weird and sometimes bizarre swapping habits of the UK population.

The 'Top of the Swaps report' published by webswappers.com at **<www.webswappers.com>**, the UK's leading online swapping site, is based on data compiled from the 7000 plus swaps placed on the site since January, by the increasing number of people who have discovered the latest phenomenon to hit the net - online swapping.

Some of the more bizarre swaps include 1.2kg of bovine gall stones (allegedly used in Chinese medicine) or there is the person with two training canoes who is willing to trade them for a pair of mannequin arms, preferably left and right.

Or if you're longing for some original fragments of the Blarney stone, direct from County Cork, Ireland, the owner is willing to be 'surprised' at your offer.

Swapping is not just about the weird and wonderful - the whole of the UK population appears to be going swapping mad. The posh swaps top ten reveals the swapping habits of the more affluent members of society.

They are swapping everything from Rolls Royces to magnums of champagne and for the man in your life who has everything how about the domain names 'the2002worldcup.co.uk' or 'the2006worldcup.co.uk', or perhaps a life like 6ft tall Laura Croft statue, they are all on offer on the site. Even homes have the 'for swap' sign up.

Leading the kids 'Swap 10' are Pokemon cards, being swapped in vast numbers, with Nidoking and Charizard the most popular cards. Computer games and CDs are following closely behind in popularity.

Three Hours a Day Wasted on Irrelevant E-mails

Recent research from The User Group has shown that information overload is growing at such an alarming rate that it could impact on the economy.

In a survey which spanned a number of different business sectors and included responses from companies such as Arthur Andersen and PriceWaterhouse Coopers, respondents claimed to spend almost three hours a day dealing with unnecessary and irrelevant e-mail.

In a similar survey conducted two years ago, the average was 90 minutes. Should the trend continue at this rate, the average next year could rise to as much as four hours per working day sifting through irrelevant e-mail - unproductive time which could lead to lack of productivity and loss of revenue.

MusicStore Jukebox Stores 200 Audio CDs in MP3 Format

DigMedia at **<www.dig-music.com>** a digital music distribution company has released the MusicStore, a consumer electronics device that incorporates a CD player, digital jukebox and a portable MP3 player/docking station that can record, store and manage up to 200 conventional audio CDs using a rights secure MP3 format.

With command of more than 2,400 songs, the MusicStore cannot only replace an entire CD collection, but is poised to redefine how music is managed and enjoyed. Consumers don't need to be computer literate or MP3 savvy to use the MusicStore.

As conventional audio CDs are played, MP3 audio is created automatically and stored to the unit's on board 6.4 GB hard drive. The MusicStore connects to any hi fi system or powered speakers and is among the first digital music systems to recognise Digital Rights Management in order to protect the original content owners from piracy.

When songs are transferred to the MusicStore's built-in portable SoulMate MP3 player, they are no longer available on the jukebox until the SoulMate is returned to its base. The transfer of songs to and from the MusicStore is also astoundingly fast - each track transfers in about a half a second.

Internet.com Acquires PDAStreet.com and Thinkmobile.com

May 30, 2000

Ticketmaster Grabs Rival

France Telecom Confirms $40 Billion Bid for Orange

AOL, Gateway Tap Transmeta Chip

Today on internet.com

Internet Technology Channel

Visual WAP Authoring Tool Unveiled

Macromedia and Nokia have teamed up to create the next wave of killer apps. They have created a WAP extension for Dreamweaver, called Visual WML. Now you can create that perfect design, and have it work on phones too!

more on this channel

Ecommerce/Internet Marketing Channel

Is Credit Card Insecurity a Problem on Your Site?

One of the best investments you can make in your website is adding a toll free number. Why do you need a toll free number if your site is ecommerce-enabled? Because some of your customers are still not comfortable using credit cards online.

more on this channel

ISP Resources Channel

The Perfect Biz Plan, Part 3

You may have a first-rate organization and a winning product, but without solid marketing your prospects for success are limited.

Web Developer Channel

Sponsored by HearMe.com

Converting Print-Based Documents For The Web

You may find your Web page content is originally supplied in Microsoft Word, Excel, WordPerfect, PageMaker, or even more

Internet.com at **<www.Internet.com>**, the Internet Industry Portal, has acquired the PDAStreet.com at **<www.pdastreet.com>** network of Web sites and Thinkmobile.com at **<www.thinkmobile.com>**, the Mobile Computing Portal.

These Web sites provide comprehensive coverage of the Wireless Internet marketplace serving the mobile community of personal digital assistant (PDA) and mobile phone users and will become the backbone Internet.com's soon to be launched Wireless Internet Channel.

The PDA Network, provides targeted mobile computing coverage for users of specific types of PDAs including: Windows CEcity at **<www.wincecity.com>** covering the Windows CE market, PalmBoulevard at **<www.palmblvd.com>** for Palm Pilot users, PsionPlace at **<www.psionplace.com>** for Psion users, and VisorVillage at **<www.visorvillage.com>** for Visor users.

Thinkmobile.com meanwhile is a premier news and information portal for the mobile communications community. Content found on Thinkmobile.com includes: daily news and information about mobile computing and wireless communications, editorials, specifications and reviews of mobile products and services.

Nearly 25% of PC Users Unprotected from New Viruses

24% of PC users at risk

Nearly a quarter of home and office PC users running anti-virus software don't update their anti-virus software at least monthly, leaving themselves vulnerable to newly minted viruses, according to a survey conducted by Central Command, a leading supplier of anti-virus software at **<www.avp.com>**.

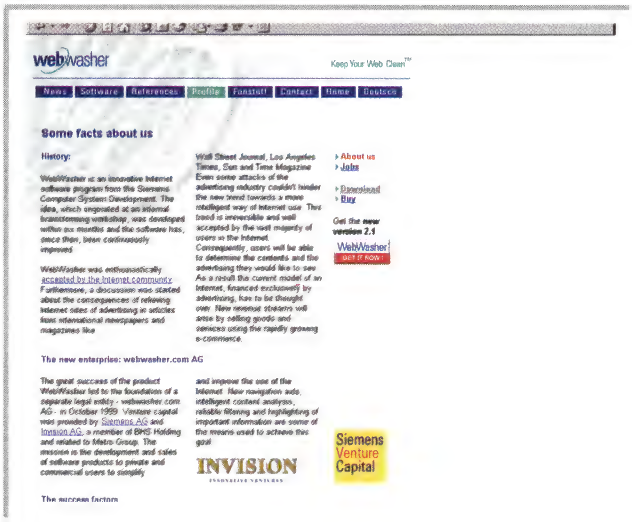
This is despite the high awareness of Internet viruses following outbreaks of the Chernobyl and Melissa viruses and the LoveLetter worm, which disabled millions of PCs around the world. The survey e-mailed to nearly half a million PC users, investigated people's encounters with computer viruses and their computer security habits.

The survey revealed that in the previous 12 months the majority of PC users (65%) had experienced at least one virus, and 57% of infections resulted in a loss of data. In addition, over 18% of respondents said they lost 'moderate' or 'large' amounts of data, and 14% reported more than five virus attacks in a year.

The survey found that 24% of respondents said they do not update their anti-virus software at least monthly.

That virus encounters are common came as no surprise, but the fact that so many PC users so infrequently update their anti-virus software may indicate a weakness in the community's defenses against cyber attacks.

webwasher.com Two-way Cookie Filter



Some facts about us

History:

The new enterprise: webwasher.com AG

The success factors

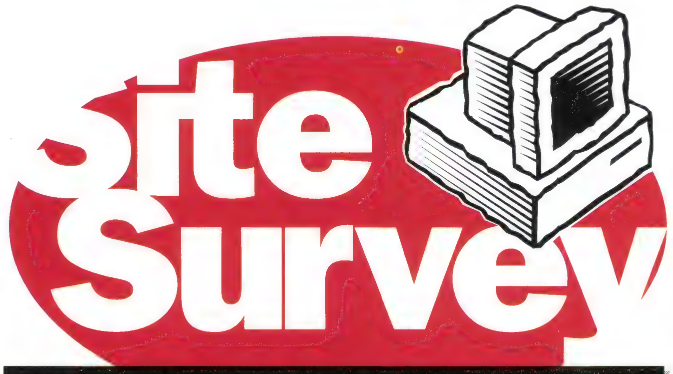
webwasher.com at **<www.webwasher.com>**, a global developer and marketer of advanced, enterprise-friendly ad filtering software, has released WebWasher 2.1 with a function that provides automatic, two-way cookie filtering. With WebWasher 2.1, individuals and enterprises can take privacy into their own hands by getting rid of the cookies that third parties use to follow them around the Internet.

Cookies are short text files placed on a user's hard drive by Web sites the user visits. Internet marketing companies use some cookies to develop profiles of individual consumer browsing and buying behaviour.

Other cookies do not represent personal information leaks and are, instead, necessary for speedy page views and efficient shopping on the Internet.

WebWasher 2.1 uses an algorithm to automatically filter out bad cookies that leak personal information about the user to third parties. Good cookies that are required - for example, to execute an e-commerce transaction - can pass by. If the cookie cannot be rated good or bad, it will get a finite life span, after which it will cease to exist.

Another unique aspect of WebWasher's cookie function is that it works in both directions, filtering both incoming cookies from a Web server and outgoing cookies called forth by an external server when a Web site is re-visited.



The months destinations

Welcome to the AbilityNet web site

click on the logo or this link to continue

Enquiries@AbilityNet.co.uk

If you need information on how disabled people can use computers, AbilityNet will likely have the information you need. AbilityNet is a charity set up specifically for the purpose of assessing disabled people and showing them what computer-based equipment they need to enjoy the technology. Located at: **<http://www.abilitynet.co.uk/>**, AbilityNet's Website is a well-organised and easily accessible database of help.

When kids are ill, it's often the parents who suffer most - mentally, at least - with worries about how little Johnny is, and what can be done to help. Parents Encyclopaedia is a good Website that can give short easily understood answers to common questions that arise with children's illnesses. The definitions and answers are not meant to be definitive, textbook style discussions. You can find it, at: **<http://www.sleeptight.com/EncyMaster>**

Short text messages (SMS) sent to mobile phones can be very useful if you could only do it via email or over the Internet. Well, you can with Genie from BT Cellnet. You can send a text message to any digital mobile phone user direct from the Website, at: **<http://www.genie.co.uk>**. Also, if you're a digital mobile phone user, you can register with Genie and have a personal Genie email address that anyone can use to send you messages. Beats pressing your mobile's number pad over and over again to write a message.

While computers appear quite bland boxes (unless they're made by Apple, of course), far under their skin developers inevitably leave their signatures in some form or other. To be truthful, real signatures aren't common, and most often developers include some oddball way of ensuring that the computers they make are just that little bit different. But you've got to look closely - most of these things are etched minutely into the integrated circuits and aren't visible with the naked eye. The Silicon Zoo, at: **<http://micro.magnet.fsu.edu/creatures>** is a Website that's been put together to show some of the things that developers get up to, and features a marvellous collection of high-magnification photomicrographs of developers work to look through.

COMMENT

by Keith Brindley

Technology for All?

This technology is a great thing. It allows us all to surf the Internet, it allows us all to have powerful computers and do things with them that couldn't be attempted just a few years ago. It means that we can communicate with others just about anywhere else in the world, it means we can view pictures and listen to music in our homes, in our cars, and on the move, all with no barriers.

Or does it? Well, yes, of course, technology does mean that some people can do all these things. And some people can do some of these things. But, and this is a big but, not all of us can do all of this.

That last point appears about to be stressed over the coming months as interested parties look set to challenge those technology providers that don't do more to help us all. Key to all this is the Disability Discrimination Act (known as the DDA), which has been partially phased in from 1995 and will be in force completely by 2004. The DDA specifies that providers of goods and services must make sure that appropriate goods and services are available to the UK's disabled people.

In particular, the goods and services that look set to be targeted by proponents of the DDA are Websites, as most Websites are inaccessible to blind people. It's looking increasingly likely that a high-profile test case will be initiated against a prominent Internet-based UK shopping site soon. The Disabled Rights Commission (DRC) is on record as saying that there needs to be a test case on the issue, and is planning to take action in some way. If the right disabled person complained that a Website was inaccessible, then the process would start and the case would be brought to court.

But what can Websites do to provide disabled access? The World Wide Web Consortium (W3C) has recently launched the Web Accessibility Initiative (WAI), in which it considers the ways to make Websites more accessible by all people, including the disabled. The Initiative's Website at: **`<http://www.w3.org/WAI>`** is quite informative, and gives several examples and suggestions. It points out that a Web page needn't necessarily in itself be accessible by disabled people, but that it should allow them easy access to equivalent pages that disabled people can access. These equivalent pages should be maintained with at least the same frequency as the main page. To give easy access to pages specifically for disabled access, meta information can be used within the page, to automatically relocate the users browser to the equivalent pages. For example, the LINK element can be used within an HTML page to link to the equivalent pages if the user's browser is identified as supporting aural or braille rendering.

The Initiative also makes the point that Web pages designed properly for keyboard access (in addition to mouse access) will generally be accessible to users with any type of input device.

Access to Websites is just the start, of course. Disabled people aren't able to do some things that non-disabled people often take for granted. In effect, the odds are against disabled people. The DDA aims to counteract this and even up the odds in some small way. Nevertheless, there's much that cannot be redressed. The key word in the DDA is appropriate. Inappropriate goods and services can't be expected to be provided - blind people, for example, can't expect to be able to drive cars; paraplegics can't expect to be refuse collectors.

But there's a world of difference between driving or emptying trashcans, and surfing the Internet. Cars and rubbish have been around in their present forms a long time. Yes, adapting them so that blind people can drive them, or paraplegics can empty them is possible, but it's just not appropriate! Well, in the short term at least - as more and more electronics and computer-control goes into cars, it's feasible that long-term cars could be so automatically driven that drivers needn't actually need to see.

The Internet, on the other hand, is new technology. It's developing constantly; it's being developed constantly because it's basically software-driven. It's also the ideal medium to build accessibility for all into it - the Web is all about tailoring content to suit users after all, more so than any other information medium has been in the past.

It's easy to write a Web page; it's only marginally more difficult to write that Web page so that it's accessible by disabled people. Website producers merely need to add a few lines of HTML code to add aural or Braille links, and quite rightly they should be made to do so by law, as in the case of the DDA.

Indeed, unless Web pages are developed properly and most likely in the ways the W3 Consortium's Web Accessibility Initiative suggest, there's an increasing likelihood that a sort of digital divide will occur, between those who have access to the Internet, and those who have none. Where there already is such a divide between the richer and the poorer of us who do and don't use the Internet, the divide will widen if disabled Internet access (or, more pertinent) lack of it, is thrown into the question.

Despite this, awareness of the DDA is poor. Most companies with Websites wouldn't know what the initials stand for, let alone what they should be doing to improve their Websites. A high-profile test case will highlight the new act, the issue, and the way forward. It seems a pity that a lawsuit will be necessary, but at least it will focus the minds of Website producers, and that can only be good news for the future.

In the end, as disabled people number some 8.5 million in the UK, with - get this - an estimated £40 billion a year disposable income, technology providers have to ask themselves if the market they are missing out by not providing appropriate access to disabled people is worth the cost of missing. In short, Web access by disabled people is an opportunity that Websites themselves shouldn't miss out on.

The opinions expressed by the author are not necessarily those of the publisher or the editor.

The Very LONG WAVES

PART 5

In this final part, George Pickworth explores high frequency alternators and submarine antennas

High frequency alternators

High frequency alternators were the most successful of all very low frequency, pre-thermionic valve continuous wave transmitters. But high frequency (HF) alternators were difficult to build and their construction taxed the ingenuity of both electrical and mechanical engineers. I therefore hope that this study will give readers an insight to the ingenuity of the pioneers and an understanding as to how those remarkable and innovative, superstation-alternators worked.

Only a handful of superstations were constructed and as far as I have records, there were only three makes of HF alternators:- Alexanderson machines made by the American General Electric Company (GE), the Osnos machine made by the German AEG company and the German Goldschimdt alternator. In their time these machines were at the leading edge of both electrical and mechanical technology.

By-product of the Arc Lamp

Like the quenched arc oscillator, the high frequency (HF) alternator, was a by-product of the arc lamp. Arc lamps provided the only practicable way to produce light from electricity before the turn of the last century and were widely used for street lighting.

Locally generated DC originally powered arc lamps but following the adoption of Tesla's polyphase power distribution system, streets lamps were generally powered by AC. Then, expansion and contraction of the arc plasma caused the lamps to produce a sound that corresponded to the frequency of the supply current. The 50/60Hz tone produced by numerous arc lamps could be intolerable.

Tesla realised that the annoying sound problem could be overcome by feeding the lamp with high frequency AC, i.e. in the order of 20kHz, so that the sound was above audibility. He also reasoned that HF current would not only solve the arc noise problem but would allow power distribution systems to use iron free transformers, which would result in considerable savings in the costs.

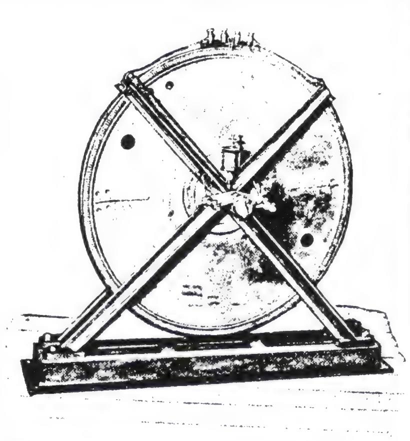


Figure 62. Tesla induction type alternator circa 1890.

But, Tesla abandoned the concept of a HF power distribution network in favour o employing rarefied air of the upper atmosphere as the conductor for long distance transmission of HF electrical powe generated by the Niagara Falls power station. This involved elevating electrodes t an altitude of about 15km by means of hydrogen filled balloons. The earth would serve as the return conductor. See Figures 31 & 33 Part 3

In 1890, Tesla succeeded in building a 10kHz alternator (Figure 62) followed by a 20kHz machine and between 1891 and 189 produced diagrams showing virtually every possible configuration for connecting an alternator to an antenna - see Figure 63. Yet Tesla did not subscribe to electromagnetic (em) waves and describes diagrams as means of transmitting electrical energy via natural media - see Figure 64.

The irony is that Tesla had elevated his antennas to a height of 15km and he actually made plans for such an attempt, and if he energised it with his 10kHz alternator he would have had a very efficien

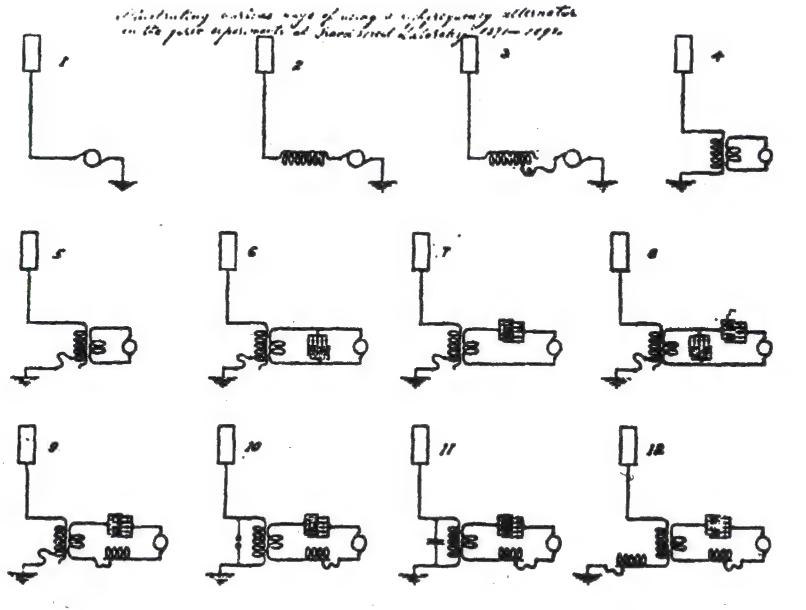


Figure 63. Tesla diagrams showing various ways of connecting an alternator to an antenna.

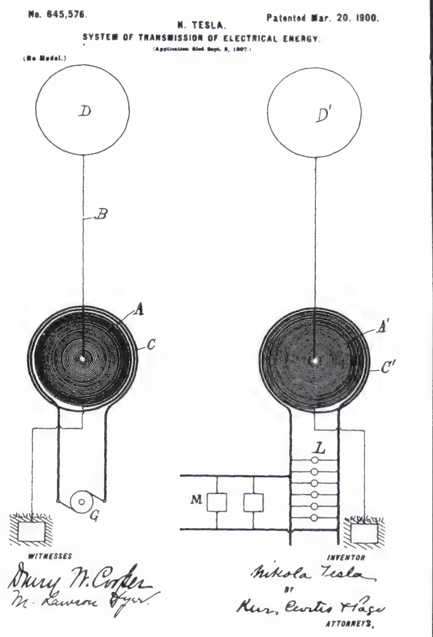


Figure 64. Tesla diagram for proposed transmission of electrical power.

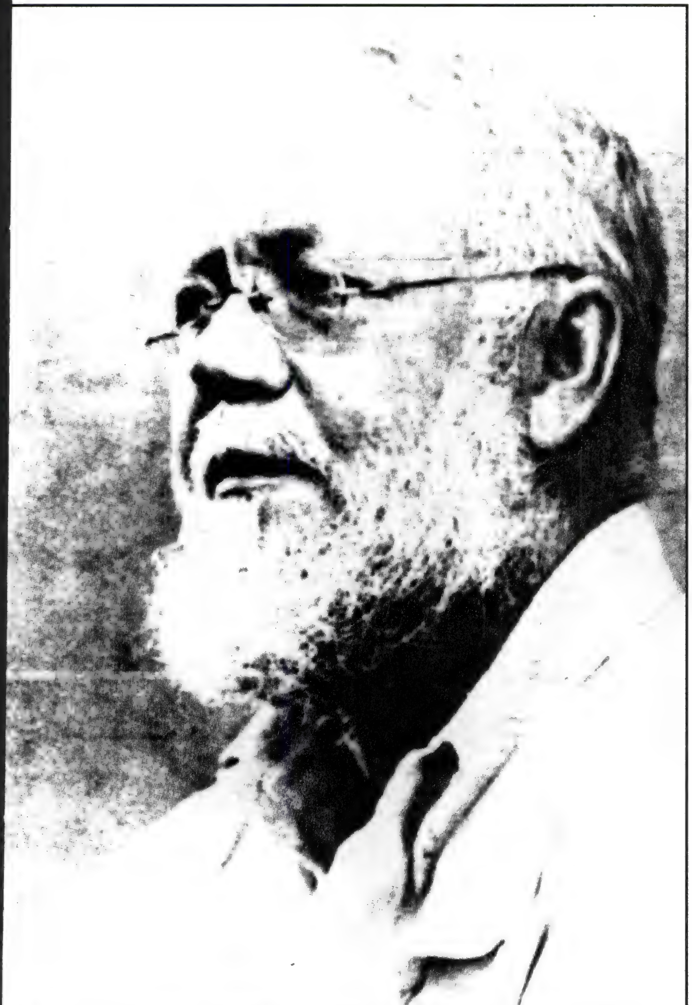


Photo G. Professor Reginald Aubrey Fessenden. 1896 - 1932

/2λ antenna and an em transmitter that heoretically would have had worldwide ange. But he would only have needed to levate the antenna to a height of 7.5km 1/4λ) which many believe would have been ossible.

In fact, during an early study of the anguine submarine signalling systems it vas proposed to employ balloons to elevate ntennas that would have been energised in xactly the same way as shown in Tesla's liagrams. But balloons were considered mpracticable so radiating earth loops were ltimately adopted. Refer to Figure 29 Part 2.

Radio Telephony

When financier Morgan withdrew his upport for Tesla, his HF alternator projects vere terminated and for some time fterwards HF alternators attracted little nterest. Remarkably it was developments vith radiotelephony (RT) that brought bout a renewed interest in these machines. The reason was that continuous waves were necessary for RT. Attempts to produce CW by means of high-speed interrupters and igh-speed spark systems had proved unsatisfactory. Quenched arc oscillators vere partially successful but waveform was ot really good enough for RT. See Part 4

Fessenden foresaw the potential for lternator systems not only for radiotelephony, out radio broadcasting and last but far from east, as an attractive alternative to spark ystems for transoceanic telegraphy. So he began to develop alternator systems from where Tesla had left off. His first HF alternator was given patent No 706,737. See Photo G.

By 1905 Fessenden had established his very long wave Brant Rock, USA to Machrihanish, Scotland link with his rotary, synchronous-spark-transmitter. Indeed, Fessenden was well ahead of Marconi with high power spark systems but was intent on upgrading his stations to alternator continuous wave systems.

Marconi and indeed many others would not accept that em radiation was possible by apply alternating current directly to an antenna; it was believed that a spark was essential. Many believed that radiation was from the actual spark! Yet, even Marconi had no option other than to ultimately adopt alternators.

Even more remarkable, J. A. Flemming referring to Fessenden's patent, asserted in his book Electromagnetic Waves that no such alternator existed and if it did, it is doubtful if any appreciable radiation would exist. But shortly afterwards, on the 24th December 1906, Fessenden, employing an 88kHz alternator confounded Flemming by making the first transatlantic broadcast. Modulation was inserting a power microphone in the antenna circuit. The rest was history.

Tesla Alternators

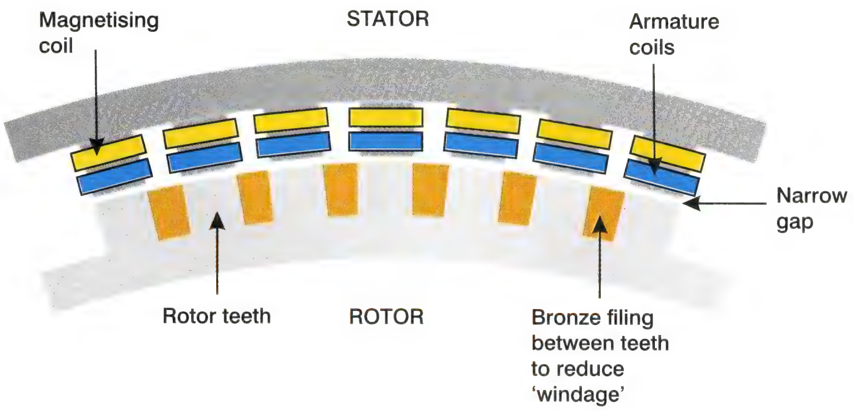
Tesla had described construction of HF alternators as difficult and complicated. Unfortunately, space only allows a brief description of their construction, however as pioneers called the armature the rotor complemented by the stator, these terms are used in this study.

Tesla made several variations to the design of his alternators but a typical machine had a stator that consisted of a ring of wrought iron with 348 internal pole projections. The field winding was wound axially in a grove around the outside of the ring and was energised by either a battery or a small DC generator - see Figure 62.

The armature, in which the oscillatory current was induced, rotated concentrically inside the stator. It was a steel disc with a wrought rim with 348 short, radial, bronze pins i.e. corresponding to the number of stator projections. The armature coils were wrapped around these pins. In some machines the armature windings were around teeth cut out of the periphery of the rotor. The projections, teeth or indeed the bronze pins are referred to as pole pieces.

Output frequency is set by the number of pole pieces multiplied by the rotational speed of the armature. So with 348 pole pieces and to produce 10kHz rotor speed was therefore 2,304rev/min. Very high peripheral speeds were essential for high frequencies, so the rotor was of large diameter. Moreover, a large diameter allowed more space for pole pieces. Nonetheless, constructional factors limited both the diameter of the rotor and the number of pole pieces.

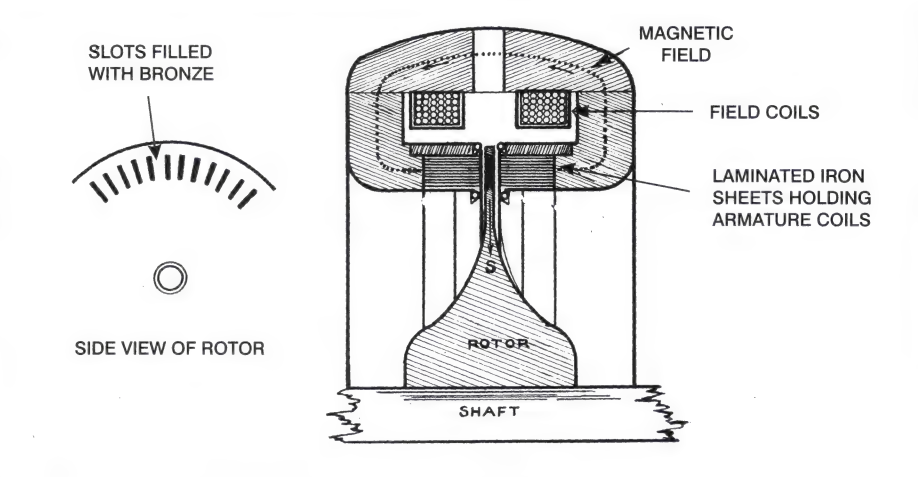
The obvious way to further increase frequency was to increase rotor speed but there was a limit as to how this could be increased before centrifugal force caused its windings to fly out off the pins or out the slots as the case might be. So, Tesla, incorporated both magnetising and armature windings on the stator; the rotor was then simply a toothed disc; this was known as an inductor type alternator and was the basis of virtually all HF alternators - see Figure 65.



Note that both field coils and armature are wound around teeth on the stator. The rotor has only teeth but the gaps are filled with bronze to ensure a smooth surface. Alexanderson alternators had an unequal number of teeth.

Figure 65. Induction type alternator - toothed rotor and stator.

Figure 66. Section of Fessenden alternator, calliper type.



Fessenden Machines

However, the drawback with the concentric toothed stator and rotor was that the gap between these two components had to be very small. But at high rotational speeds the diameter of the rotor increased as a result of centrifugal force and this made it difficult to maintain the required degree of gap width.

So Fessenden employed a disc rotor with slots around its periphery that ran between the calliper shaped cross section stator that held both magnetising and armature windings. The calliper design allowed the rotor to increase in diameter, without the danger of it coming into contact with the stator. Moreover, the calliper design allowed the gap between the sides of the rotor and the calliper to be very narrow; indeed this was vital for efficient operation of the machine - see Figure 66.

A Balance

As we have seen, for his Brant Rock/Machrihanish link, Fessenden opted for a frequency of 88kHz and this enabled a reasonably sized antenna to give good radiation. On the down side, the alternator had to run at very high speed. Whilst lower frequencies were found to be better suited to transoceanic signalling, a balance had to be struck between wavelength and antenna radiation efficiency.

Fessenden's 88kHz, 50kW machine had 360 pole pieces so the machine ran at 14,640rev/min. However, little difficulty seems to have been experienced in running the machines at such high speeds via a simple flat belt.

Originally, the antenna was connected directly to the alternator and the inductance of the armature was utilised to bring the antenna circuit into resonance. Later, Fessenden employed antenna coupling transformers similar to those shown in Tesla's diagrams; this allowed the alternator impedance to be matched to that of the antenna - see Figure 63.

Alexanderson Machines

Fessenden handed over production of his alternators to the American General Electric Company (GE) where they were built under the supervision of Alexanderson. Hence the name. The fact that Fessenden developed the prototype was soon forgotten.

Early GE machines were of Fessenden's calliper design, but to reduce 'windage' the slots in the rotor were filled with phosphor bronze. The first machine had 300 pole pieces. So in order to produce 100kHz the rotor ran at 20,000revs/min! Not surprisingly, such high rotor speeds caused the bearings to become extremely hot and operation at this speed was unsustainable.

But as we have seen, such high frequencies were unnecessary even for telephony. Indeed the original radiotelephone link between Rugby and the USA was only 30kHz. Transoceanic superstations also opted for a lower frequency where poorer radiation efficiency of practical sized antennas was offset to some extent by lower attenuation of the transmissions. Lower frequencies also allowed alternators to run at lower speeds and this was a very important consideration.

Indeed, the only compelling reason for adopting a higher frequency, i.e. in the order of 50kHz, was to find a 'slot' in the limited a space of the very low frequency band, or for better radiation where physical restraints limited antenna size. But frequency raisers could be employed to increase the alternator fundamental frequency by a factor of four.

Back To Concentric Design

The drawback to the calliper design was th it was less efficient than the toothed rotor and stator design. So Alexanderson reverte to the toothed rotor and stator concentric design. The gaps between the rotor teeth were filled with bronze so as to present a smooth surface - see Figure 65.

Moreover, as the machines ran at relatively low speeds, the effect of centrifugal force on the rotor was much reduced and this allowed a very narrow ga to be maintained between the stator and the concentric rotor.

Later, it found that by having 300 teeth o the rotor and 400 teeth on the stator it was possible to produce the same frequency as with 600 teeth on both rotor and stator. So compared with earlier machines with 300 teeth on both rotor and stator, drive speed could be halved.

Two 200kW Alexanderson alternators of the above type were installed at Marconi's Caernarvon station in 1921; one was operational and one in reserve. They were driven by 300kW two-phase electric motors and ran at 2,100 revs/min so frequency was 21kHz.

Speed Control

As frequency is set by the speed of the rotor, precise speed control was vital. With Alexanderson machines, one of the alternator' armature coils supplied current to an inductance/capacity circuit having a resonant frequency slightly higher than the required frequency.

By operating at the bottom end of the resonance curve, changes in the speed of the rotor and therefore frequency caused the current in the resonant circuit to rise or fall. Some of the current was rectified and used to operate relays that in turn operated a magnetic amplifier that controlled current to the drive motor.

Briefly, the operation of magnetic amplifiers involves saturation of the core of a 'transformer' by applying DC to its primary winding. An increase in DC causes a proportionate fall in the inductance of the secondary. A small direct current can therefore control a large alternating current, hence the name magnetic amplifiers.

Keying was by means of a magnetic amplifier

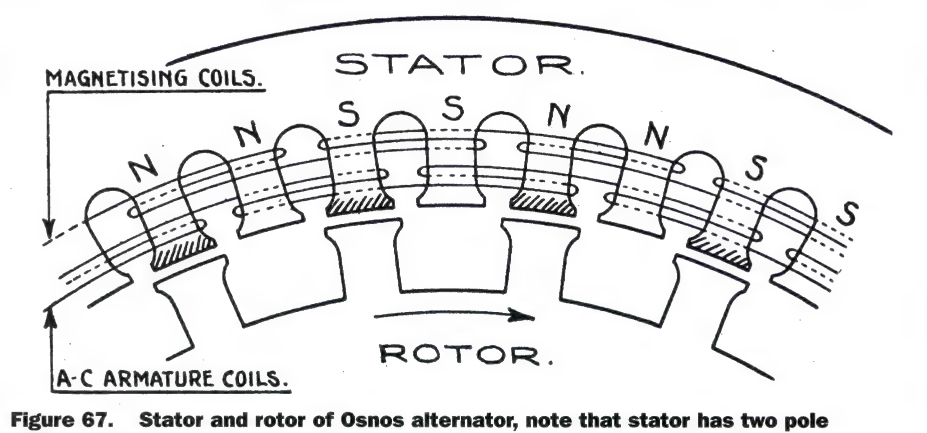


Figure 67. Stator and rotor of Osnos alternator, note that stator has two pole pieces to one on the rotor.

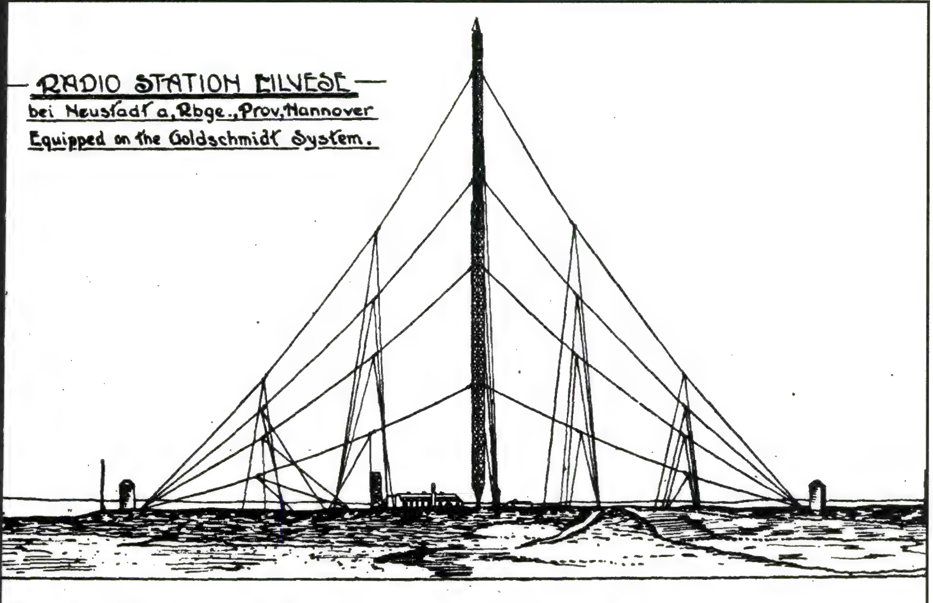

RADIO STATION EILVESE
bei Neustadt a. Rbge., Prov. Hannover
Equipped on the Goldschmidt System.

Figure 69. The antenna: Eilvese superstation Germany. The station worked Tuckerton USA on 60kHz, and employed the Goldschmidt transmitter of Figure 68.

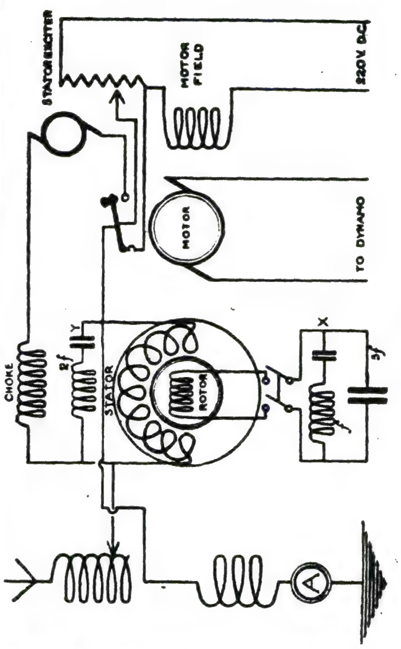


Figure 68. Goldschimdt alternator, note tuned circuits across the rotor and stator.

between the alternator and antenna. However, in order to compensate for the changes in load on the drive motor, a relay working synchronously with the signalling key cut out a load resistor in motor's rotor circuit when the key was pressed.

Osnos

M. Osnos's alternator was similar in design to the Alexander machine but each stator pole had two teeth per pole whereas the rotor had only one tooth per pole. The effect was that of increasing the number of pole pieces - see Figure 67.

Typical machines were rated at 15kW at 50kHz but I have no record of the drive speed or the number of actual pole pieces. The design was patented and adopted by the AEG Company of Berlin and machines were used widely by the Telefunken Company.

Goldschmidt

These machines did not run very high speeds so fundamental frequency was low. However, resonance circuits across both the rotor and stator enabled the machine to deliver current at four times its fundamental frequency - see Figure 69.

The feature of the Goldschimdt alternator was that the stator coils were joined up, so an alternating current passing through these coils caused a magnetic field to rotate around the inner periphery of the stator at a speed set by the frequency of the current, i.e. similar to the stator of an ordinary induction motor.

When operational, the magnetising current was induced in the stator. So when the stator coils were joined up such that the direction of the magnetic field rotated opposite to the rotor, the output frequency was double that compared to a stationary magnetic field.

By connecting several machines in cascade very high frequencies could be attained but then serious losses occurred. However, Goldschimdt achieved a similar effect with one rotor and one stator. A simplified explanation of its operation is as follows - see Figure 68.

Magnetically Coupled

DC initially energised the stator field coils but when the operational frequency of 15kHz was reached, choking coils isolated the DC energiser from the field coils. Now, as both the rotor and stator were magnetically coupled, the rotor induced a current in the stator but as a result of the magnetic field rotating in opposite direction to the rotor, the frequency of the induced current was 30kHz. It will be seen that the rotor is connected to a tuned circuit that resonates at both 15kHz and 45kHz.

Rotor/stator interaction now caused the stator to induce a second current with a frequency of 45kHz in the rotor and this is accentuated by the resonant circuit. Then, the rotor induced a second current of 60kHz in the stator and this frequency was selected by the antenna's tuned circuit.

Goldschmidt 150kW transmitters were employed at the Eilvese superstation in Germany and at its complementary station at Tuckerton USA. The antenna was supported by a steel tower 250m tall and was a combination of an umbrella and double cone; it was made up of 36 bronze cables extending over a radius of 500m - see Figure 69.

Frequency Raisers

M. Joly and M. Phobi developed 'frequency raisers' based on the non-linear saturation characteristics of the cores of toroidal transformers. Briefly, operation is as follows.

With reference to Figure 70, when an iron cored inductor is magnetised by DC, the magnetising force is represented by H and the resulting magnetic flux by B. The curve shows how magnetisation varies with the magnetising force. The upper flat portion of the curve corresponds to saturation.

If the core of a toroidal transformer is magnetised with DC so that the magnetic flux is at the point A on the curve and the alternating current is in separate winding, the resultant magnetisation is shown by the dotted 'a' 'b' 'c'.

Telefunken System

The Telefunken Company system employed two 'transformers' with toroidal cores magnetised almost to saturation by DC through the windings 'D'. The choking coil L prevented high frequency (HF) current flowing into the battery circuit. The alternator was connected to the primary circuit, coils 'P' via its resonant circuit, coil L and capacitor K. Output was from the secondary circuit, coils 'O' - see Figure 71.

When HF current flowed through the primary circuit, the HF current and DC

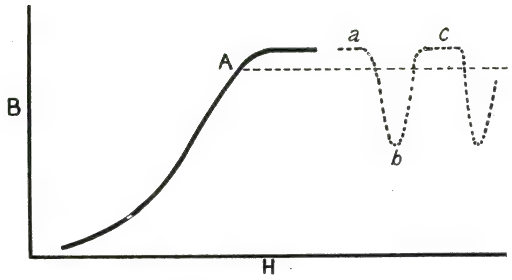


Figure 70. Non-linear saturation of the core of a toroidal transformer

H - magnetising force, B - resulting magnetic flux. Dotted area see text.

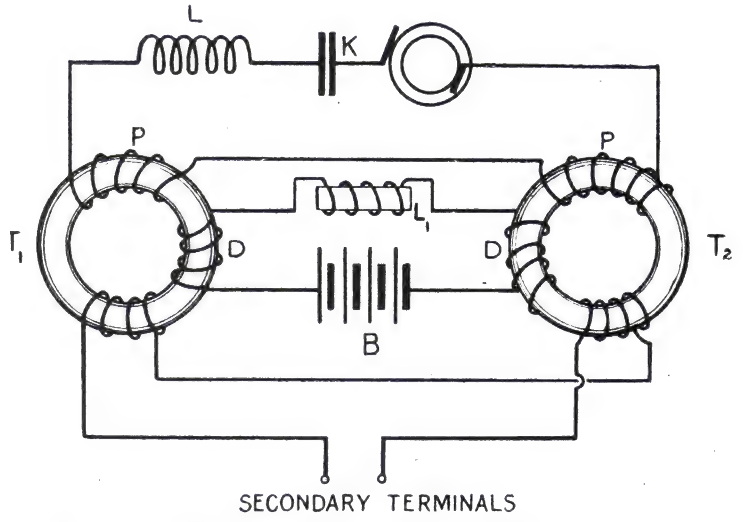


Figure 71. Telefunken frequency raiser - see also Figure 72.

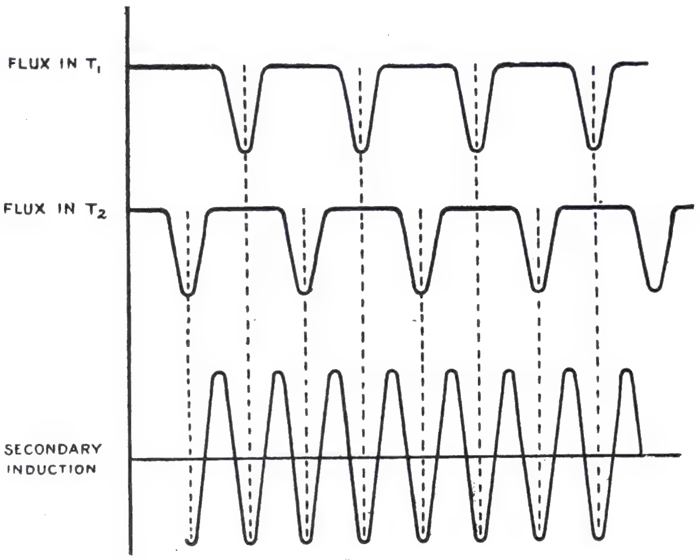


Figure 72. Representation of operation of the Telefunken frequency raiser - see also Figures 70 & 71.

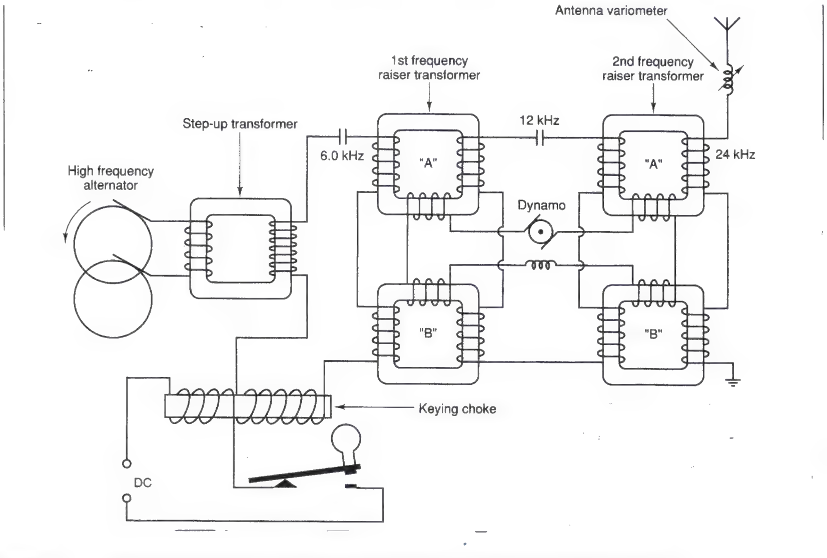

Antenna variometer
1st frequency raiser transformer
2nd frequency raiser transformer
Step-up transformer
12 kHz
6.0 kHz
24 kHz
High frequency alternator
"A"
"A"
Dynamo
"B"
"B"
Keying choke
DC

Figure 73. Schematic of frequency raisers of Nauen superstation.

alternately aided each other in one 'transformer during one half cycle' but we in opposition in the other 'transformer'. When aiding, the magnetic flux did not ris as the iron was already near saturation, bu it falls significantly when opposing.

The result is shown in Figure 72 where i will be seen that current frequency in the secondary circuit is double that of the primary circuit. Output from the secondar circuit was delivered to a tuned circuit. Th accentuates higher frequency and suppress lower frequency.

Nauen

The 1914 German strategic transmitter at Nauen employed an alternator with a fundamental frequency of only 6kHz but frequency raisers employing four toroidal 'transformers' increased output to 24kHz. Keying was by saturating the core of an inductor in series with the step-up transformer and the first pair of frequency raiser 'transformers' - see Figure 73.

Strategic

Following the British navy's successful submarine signalling trials shortly before WW1 it is almost certain that during the wa operational signals were transmitted to British submarines by the commandeered Caernarvon very long wave superstation. S there seems to be no reason why 'U' boats should not have received signals from Nauen.

In 1925, Britain commissioned its first true strategic station, GBR at Rugby. The role of GBR in signalling to submarines during WW2 has already been mentioned s let us now move on to submarine antennas

Submarine Antenna

Like the Sanguine radiating earth loop, (refer to Figure 29 Part 3), submarine antennas had their roots in pre-Hertzian signalling systems. As we have seen, before the turn of the last century, Preece had shown that his 'earth current signalling system' could induce a current in submersed antenna. Preece employed an insulated wire, terminating with an exposed electrode, trailing behind a tugboat in the Bristol Channel. The hull of the tugboat formed the second electrode - see Figure 74, and refer to Part 2.

Early submarine antennas consisted of insulated wire terminating in an electrode that gave the necessary buoyancy so that the antenna trailed upwards to the ocean surface. The submarine's hull formed the second electrode.

More sensitive receivers developed during WW2 enabled signals from GBR to be received by submarines over most the world. But the antenna had to be towed fairly close to surface of the ocean. However, because of noise generated within the submarine the antenna was connected to the end of the transmission line - see Figure 75.

Post War Period

During the post war period, submarines were required to operate at ever increasing

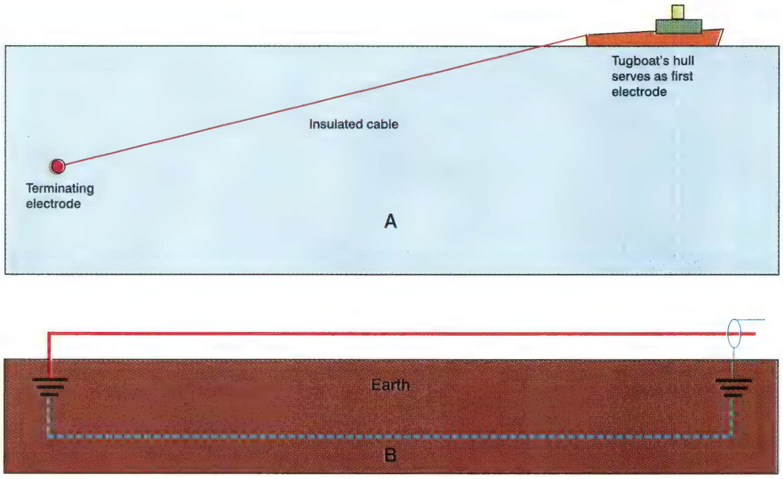
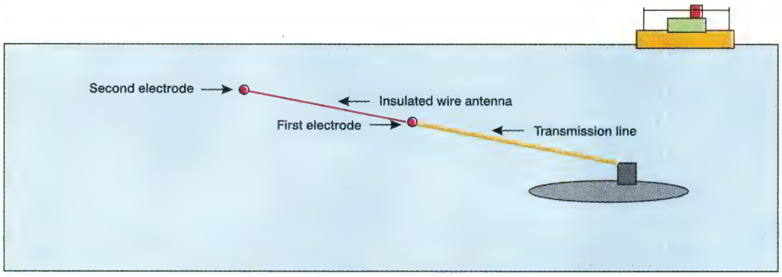


Figure 74. **a) Preece's underwater antenna' used during the Bristol channel trials.**

b) Equivalence of the underwater antenna with an earth loop antenna.



The actual antenna is similar to Preece's underwater antenna except that the first electrode replaces the tug boat's hull

Figure 75. **Submarine antenna and transmission line.**

epths where reception was beyond the apabilities of WW2 equipment.

So, during early 1960, when the Sanguine roject was launched, a study was made of ther physical phenomena such as sound ressure waves in water and electromagnetic nduction that might be employed as an lternative to VLF em systems. Esoteric ystems were considered that included nodulation of dynamo currents flowing in he ionosphere. See Part 1.

But ultimately, extremely long em waves (ELF) were selected as these were known to penetrate seawater to a much greater depth than VLF. Moreover, the generation of current in the ELF range could be achieved by means of well-established audio frequency techniques. Alternators would have seemed the logical choice, but signalling involved complicated waveforms that audio techniques were best able to handle - see Figure 79.

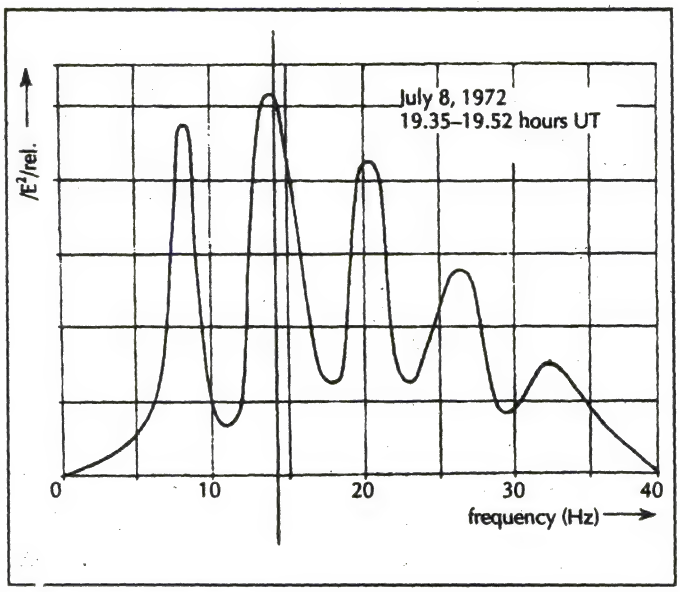


Figure 76. **Schumann resonances.**

Sferics

Before 1962, no radiating system existed to enable the propagation and attenuation of ELF waves to be actually measured. So researchers had to rely on data obtained from sferics (atmospherics) and the best known being 'whistlers' generated by distant lightning discharges; they were heard by both Preece and WW1 earth current signallers. Indeed this accounts for the otherwise unexplainable interest in 'Whistlers' at that time.

Whistlers cover a broad band of audio frequencies and were of particular significance because they propagate through the earth ionosphere/waveguide. In fact Schummann employed 'whistlers' to determine the frequency at which em waves resonated within the earth ionosphere/wave guide; these became known as Schummann resonances see Figure 76.

Sferics served as a good signal source against which to compare noise levels caused by submarine machinery, surface potentials, water motion and bubbling. The next matter was to design and construct an antenna to actually radiate ELF waves.

Satellite Trailed

Horizontal wires trailing from aircraft were commonly used as radiators of medium and long waves, but for good radiation of extremely long waves the length of the wire needed to approach λ/10, i.e. many km. This was out of the question with aircraft. Moreover, vertical antennas producing vertical electric (E) fields were necessary to excite em waves in the earth/ionosphere waveguide. Refer to Figure 45 Part 3.

Consideration was given to trailing a wire many miles long from an orbiting satellite. But the idea was discarded not only for practical reasons but it was believed that like the aircraft trailing antenna, it would not excite the earth/ionosphere waveguide.

Elevated By Helicopter

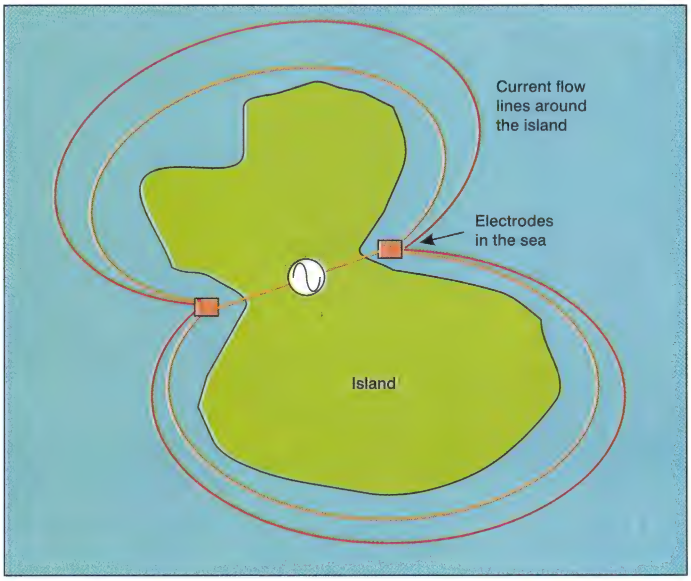
A long wire suspended from a helicopter would produce a vertical E field (Shades of Tesla's concept of balloon elevated antennas) but the problem was weight and tensile strength of the wire. A wire strong enough to be suspended from a height of several miles would be too heavy to be carried by a helicopter. Moreover the operational height of helicopters was limited. Balloons were considered, but this approach was not considered to operationally feasible.

Island Slot

Its concept was that the seawater surrounding the island would provide a lower resistance path, but of longer distance than that directly across the island - see Figure 77. Early tests across Long Island showed that a current path through the water could not be relied upon and the idea was abandoned. Nonetheless, this antenna was the precursor of the earth loop radiator. Refer to Figure 29 Part 2.

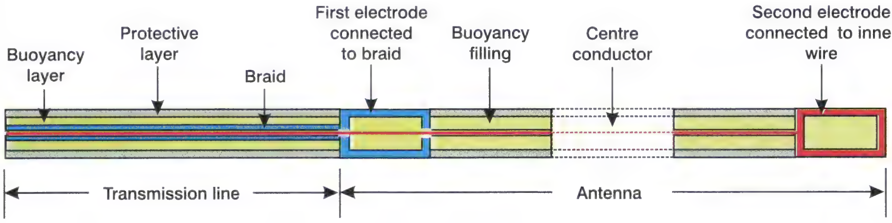
Parallel

Developments in transmitting antennas paralleled developments with submarine antennas and various types and configurations



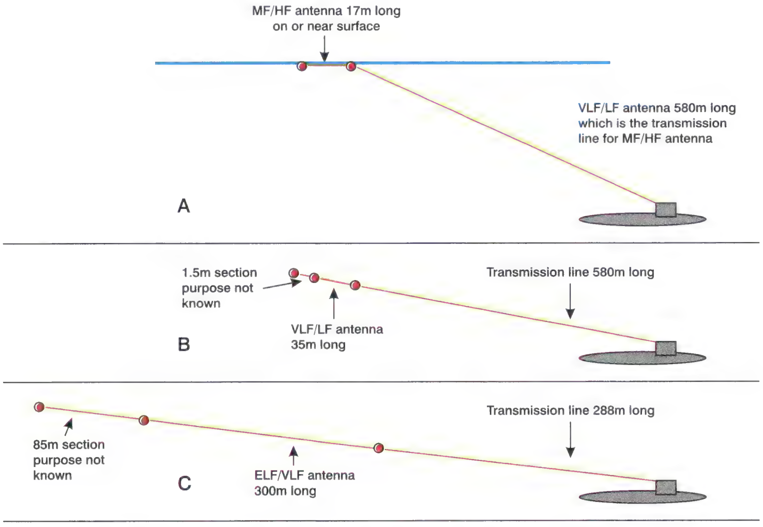
Compare with current flow lines in the earth loop antennas Figures 15 & 16, issue 150.

Figure 77. Island slot antenna



Early machinery inside the submarine for deploying and retrieving the antenna could only handle rigid electrodes. Later versions used much longer flexible electrodes including segmented metallic or carbon tubes, helical wires or conductive polyethylene

Figure 78. Boyant submersible antenna and transmition line



Typical towing configurations for boyant-cable antennas

were tried.

In the search for a low noise underwater receiving antenna, orthogonal loops and insulated wires with exposed electrodes were evaluated. However, tests showed the best receiving antenna to be one with widely spaced electrodes, (identical to Preece's underwater antenna). But the submarine itself produced spurious signals so the antenna was connected to the submarine via a long transmission line so as to keep the antenna well a way from the submarine and thereby reduce noise levels - see Figure 75.

Loops to sense the magnetic field were also tried but noise levels were greater than with the electric field, probably because of the magnetic fields produced by on-board electric motors.

Buoyant.

Since the early 1960's, US, and presumably also British submarines, employed a trailing wire antenna that was simply a conductor encased in a buoyant polyethylene foam jacket referred to a buoyant cable. The transmission line section was either coaxial or a 'twisted pair.' The antenna section consisted of a single insulated section with the first electrode at its junction with the transmission and terminated at the second electrode - see Figure78.

Hull Mounted

The drawback with buoyant cables was their short life and susceptibility to being cut by the submarine's propellers during extreme manoeuvres. So trials were made with the antenna mounted on the submarine's hull. A further advantage of this arrangement was that crossed electrode pairs could be used to obtain omniaziumuthal antenna response patterns as opposed to the figure of '8' pattern with the buoyant cables.

Unfortunately, noise was injected into hull mounted antennas by corrosion occurring over the surface of the hull; this proved a complex problem. The only real answer was to return trailed antennas but extending from a long transmission line thereby keeping the actual antenna well away from the submarine see Figures 75 & 79.

However, the electrodes of trailed antennas were noise generators especially below 100Hz and this increased with towing speed, but by careful choice of electrode material, i.e. carbon fibre this noise was reduced to an acceptable level.

Digital

In recent years developments in communications have continued apace, especially with regard to digital systems, (see Figure 80) but antennas obey physical laws and whilst their design is continually being improved I cannot see how they could have significantly changed from the already tried and tested systems.

But alternative signalling methods mentioned in part 1 that were not based on em waves, were considered during the Sanguine project ; these may well have been developed and now be operational. Presumably they would employ esoteric sensors. And there I must end this study.

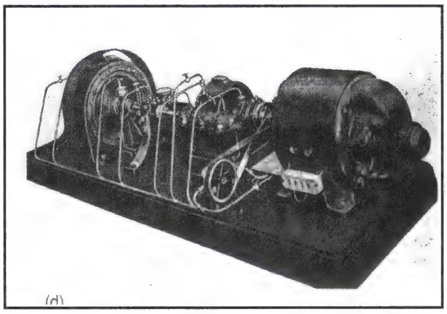


Photo H. Fessenden/ Alexanderson alternator. The alternator is on the left, drive motor on the right. Note gear drive, belt drive oil pump and feed lines to bearing

Fuel Cell DEVELOPMENTS

Reg Miles looks at how the desire for zero and ultra low emission vehicles is spurring on the development of fuel cells

The fuel cell is one of those technologies that is perennially going to solve the problems of this, that or the other industry, but never actually does. This is partly the fault of manufacturers overstating the capabilities of the state of the technology, and partly media hype. But the progress of development is accelerating, due mainly to the impetus in the USA for zero emission and ultra low emission vehicles (ZEV and ULEV) and, at the other end of the scale, the multiplication of portable products using small batteries - mobile phones, camcorders, PDAs notebook computers, etc. So 161 years after William Grove discovered the fuel cell principle it finally looks as if it is on the verge of solving at least some of the power and related pollution problems.

Limited Production

At present their production is limited. They also tend to be used in mundane roles, such as backup generators, or combined heat and power generation (CHP) in which the fuel cell generates electricity and the heat from oxidation goes to a heat exchanger for hot water and/or space heating in applications from domestic to local power stations (Figure 1). The roles that attract headlines, such as their use in cars, buses and boats, and the replacement of batteries in consumer items, are generally just a one-off to demonstrate progress (and to gain financial backing) or are part of on-going projects. Because the numbers of those that actually are being manufactured is limited they are expensive and quite likely to be subsidised by those with vested interests or that want to prove their 'green credentials'.

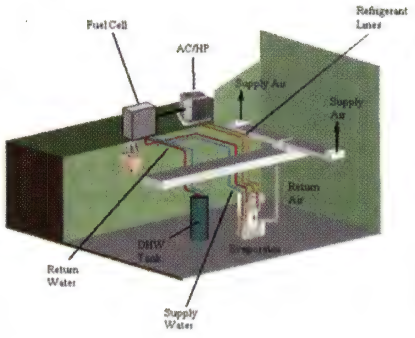


Figure 1.

The year 2001 seems to be favoured by a number of companies for either beginning the manufacturing of those fuel cells that will have some of the headline attracting roles or to increase production of those that are already being manufactured. Realistically, however, the expansion of the technology into a wider variety of roles and the reduction in prices that will make it attractive to both the customers for those and the existing roles are likely to be spread over the first decade of this century - and, in some cases, the following decade. Whatever the media and investors want to believe, or want others to believe, the technology is a long term one. If electric generators and batteries are going to be replaced by fuel cells it will be later rather than sooner.

Fuel Cell vs Battery

Although fuel cells and batteries have similarities - they both produce electricity by electrochemical means, the two technologies are actually quite different. A fuel cell is not a storage device like a battery; electricity is only produced when fuel, normally hydrogen, is flowing through it - stop the flow and the current stops. Obviously there are both advantages and disadvantages to this. It does not become exhausted like a primary battery and need to be replaced, or need to be recharged in the case of a secondary battery. When the fuel runs out it is refuelled - always assuming that you are in a place where it is widely available or you have a supply with you. The fact that it is not self-contained has always counted against the fuel cell: the need to carry hydrogen in some form provides cause for concern, as well as adding to the overall weight and volume. However, the only other requirement is for an oxidant - and that is normally taken from the air. The process of oxidation does produce some heat; and, unlike a battery, there is some emission of vapour - which, if the fuel is pure hydrogen, is only water: but one or both could render it unsuitable for some uses, while making it particularly attractive for others.

There are five basic types of fuel cell; and these are generally known by the electrolyte that is used.

Polymer Electrolyte Membrane

One that was first used by NASA for the Gemini space programme and is growing rapidly in popularity due to its potential for not only small scale CHP, power generation and electric cars but a replacement for rechargeable batteries is known variously as the proton exchange membrane or polymer electrolyte membrane (PEM), or sometimes the polymer electrolyte or solid polymer fuel cell (PEFC/SPFC). Whatever, it employs a thin film (membrane) as the electrolyte that separates the anode from the cathode (Figure 2). The electrodes are typically 5-50μm thick and are coated onto the membrane that will vary in thickness from 50-175μm - this is known as the membrane/electrode assembly. The electrodes are made of porous carbon, and

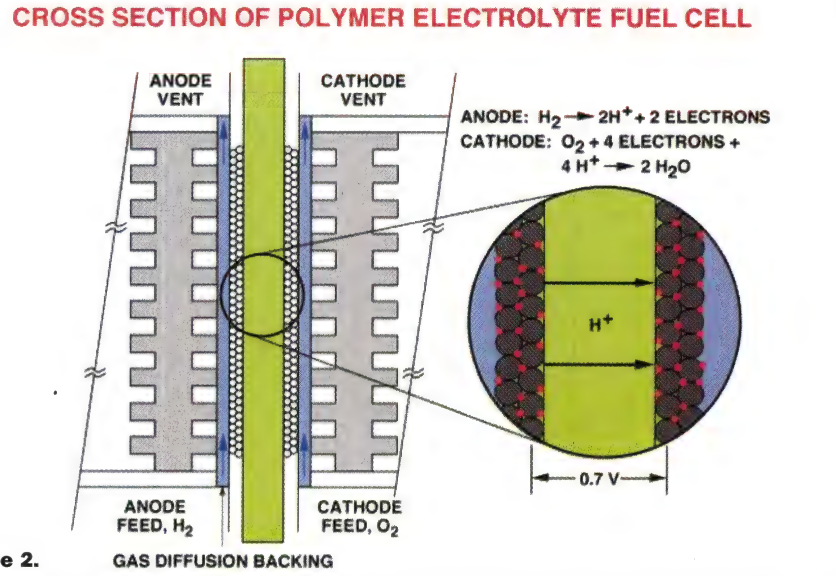
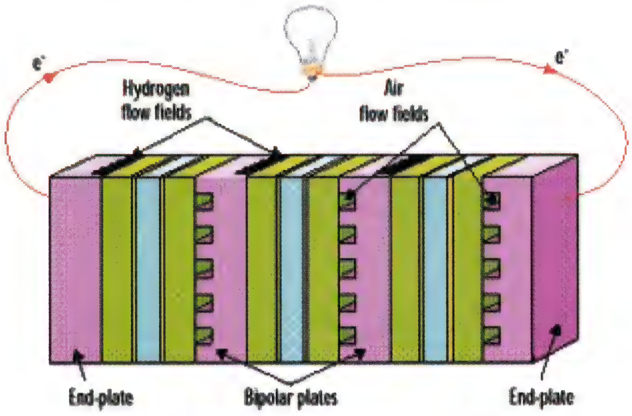

CROSS SECTION OF POLYMER ELECTROLYTE FUEL CELL
ANODE VENT
CATHODE VENT
ANODE: $H_2 \rightarrow 2H^+ + 2$ ELECTRONS
CATHODE: $O_2 + 4$ ELECTRONS + $4H^+ \rightarrow 2H_2O$
H^+
0.7 V
ANODE FEED, H_2
CATHODE FEED, O_2
GAS DIFFUSION BACKING

Figure 2.

Figure 3.



A 3 cell fuel cell stack with two bipolar plates and two end plates.

contain a catalyst of dispersed platinum (Pt) particles to expedite the anode and cathode reactions at the comparatively low operating temperatures of 50-100°C; the membrane is generally made of a perfluorocarbon sulfonic acid ionomer. Oxidation occurs at the anode, producing hydrogen ions (protons) and electrons from the hydrogen gas. Only the positive ions can pass through the humidified membrane, the electrons that are left behind thus produce a potential negative voltage. On the other side of the membrane the hydrogen ions mix with oxygen, but for reduction to occur electrons are needed. This creates an electrical potential between the negative anode and the positive cathode. The electrons that were left behind flow through an external circuit from anode to cathode, providing the electrical power, and combine with the hydrogen ions and oxygen to complete the reduction and produce water. This may then be used to humidify the membrane, or be carried away if humidification is provided by water introduced into the hydrogen and air. The membrane, incidentally, is also the barrier that prevents the hydrogen and oxygen mixing (the oxygen may be neat or taken from air, in the latter case supplied either by a compressor or from the ambient air depending on the design).

On either side of and in contact with the membrane/electrode assembly there are gas diffuser or backing layers. These are typically 100-300μm thick, and are generally made of either porous carbon paper or cloth: carbon, in order to conduct the electrons out of the anode and into the cathode; porous, to spread the hydrogen and oxygen as uniformly as possible over the electrodes and so maximise catalysatio They also perform the task of balancing hydration: if they hold too much water it will reduce gas diffusion through the layers while if they hold too little the membrane will dry and its conductivity will fall.

The cell is completed by current collect plates at either end. These may be made o either graphite or metal, although composite materials are finding increasing favour. They generally serve a dual role: firstly, as a gas flow field distributing the hydrogen and oxygen evenly over the backing plates through machined channels (which also control hydration); and secondly, conducting the electrons from th anode backing layer out of the cell through an external circuit to the load and back int the cell to the cathode backing layer. Because a PEM only operates at about 0.7V they are usually arranged side by side in what are known as stacks; and then the current collector plates become bipolar plates with flow fields on both sides (Figure 3). In this case the electrons are then conducted from the anode of one cell to th cathode of the adjacent cell, and the stack i completed by end plates that are connecte via the external circuit. Stacks can also be connected - in series or in parallel.

Incidentally, 0.7V represents about 60% efficiency, with the remaining energy turning into heat. The theoretical maximum voltage obtainable is 1.23V; although under typical operating conditions this declines to 1.16V; and present day PEMs are unlikely to operate at more than 0.9V.

PEM Variations

There are also a couple of variations on the PEM 'direct hydrogen' fuel cell. One is the reformate hydrogen cell, that uses fuels such as natural gas, methanol, ethanol, even petroleum now, that have been converted into hydrogen by an external reformer. The other variation is the direct methanol fuel cell (DMFC), where the anode catalyst extracts the hydrogen from the methanol. This latter type obviously has considerable potential for small to medium size applications where carrying pure hydrogen in some form or reforming other fuels would prove a barrier to success in consumer driven markets. Much of the work on PEM types has been done by the Los Alamos National Laboratory in the USA, and companies are licensing the technology for commercialisation.

Although there are different types of fuel cells, they all follow the same general arrangement.

Alkaline Fuel Cell

The alkaline fuel cell (AFC) was the type that finally showed the potential of the technology after more than a century of experimentation with limited success. In

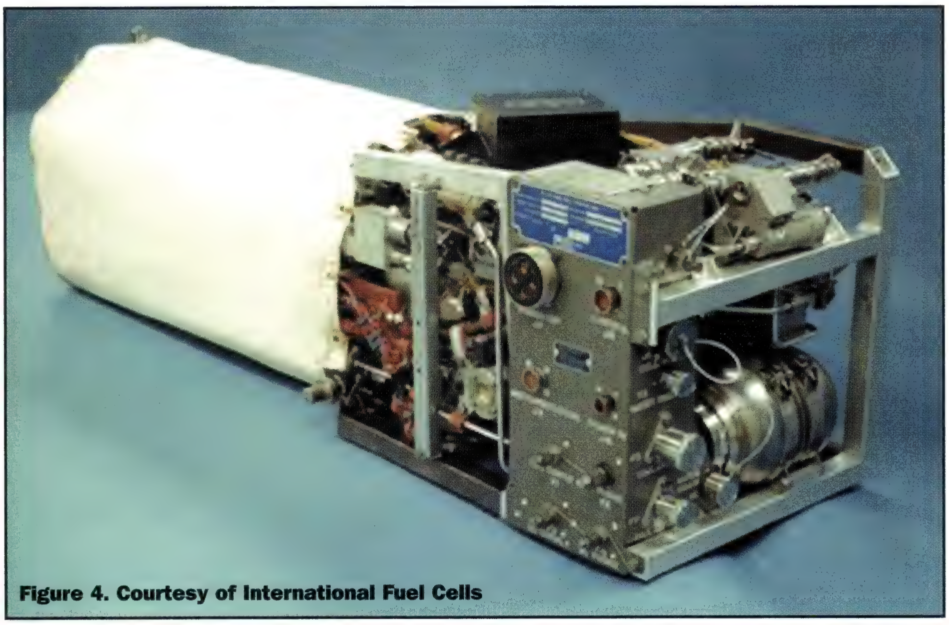


Figure 4. Courtesy of International Fuel Cells

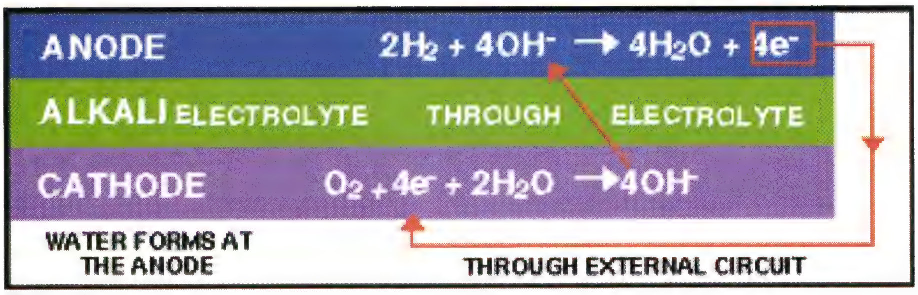
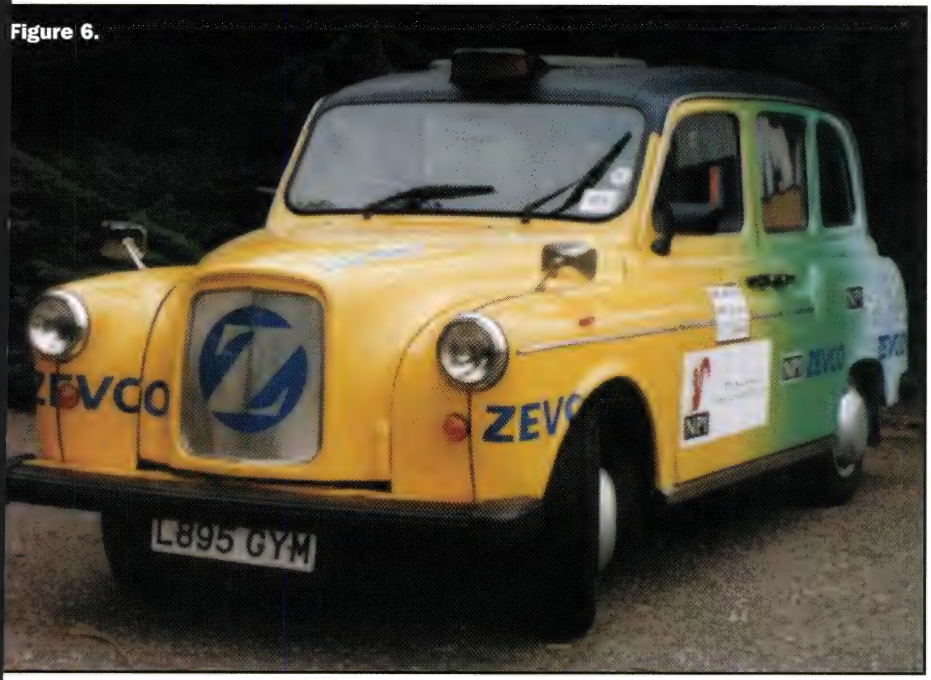


Figure 5.

Figure 6.



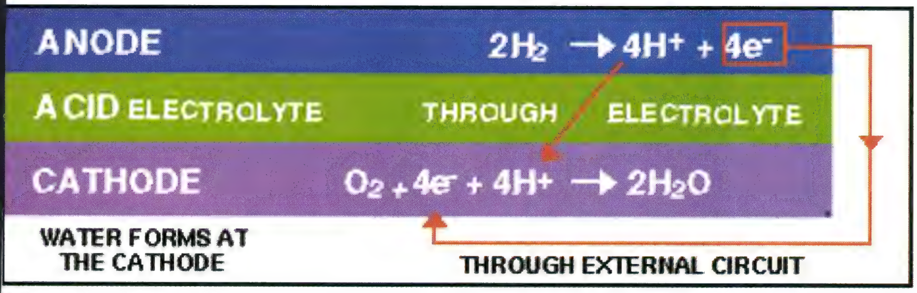

ANODE
$2H_2 \rightarrow 4H^+ + 4e^-$
ACID ELECTROLYTE
THROUGH ELECTROLYTE
CATHODE
$O_2 + 4e^- + 4H^+ \rightarrow 2H_2O$
WATER FORMS AT THE CATHODE
THROUGH EXTERNAL CIRCUIT

Figure 7.

959 Francis Bacon and his team at ambridge University demonstrated their uel cell powering a forklift truck and a velding machine. This led International Fuel ells to develop AFCs, which NASA chose to se for the Apollo, Apollo-Soyuz and Skylab rogrammes (all based on the Bacon echnology). The same company has upplied all the second generation AFCs for he Space Shuttle Orbiter. Three 12kW cells re installed under the payload bay (Figure), using hydrogen and oxygen from ryogenic tanks. Not only do they provide ll the power for the shuttle, but also water or drinking and cooling. No backup batteries are provided, nor needed - for just one AFC can guarantee the shuttle's safe eturn. And they have proved very reliable over the years.

The electrolyte in an AFC is usually potassium or sodium hydroxide; and the electrodes are normally carbon with a nickel catalyst. Hydrogen at the anode reacts with hydroxyl ions from the electrolyte producing water and releasing electrons (Figure 5). These go via an external circuit o the cathode, where they react with oxygen and water to produce more hydroxyl ions that pass through the electrolyte to replenish those used at the anode. Twice as much water is produced at the anode as is used at the cathode, so it must be drained off.

AFCs operate at temperatures of 50-250°C. They can also be made to achieve an efficiency of up to 80%, and those used for the Space Shuttle achieve over 70%, although much depends on the design.

In addition to being used by the Space Shuttle, AFCs are being used in vehicles, boats and stationary applications. One company that is involved in all three areas, and one of the few UK based companies to be manufacturing fuel cells, is ZeTek Power. Their Millennium Taxi is running in London (Figure 6) and they have provided fuel cells for a canal narrow boat, among other projects. The company is also building the world's first fully automated fuel cell production plant in Cologne; with the first of four production lines expected to be operational this July.

Phosphoric Acid Fuel Cell

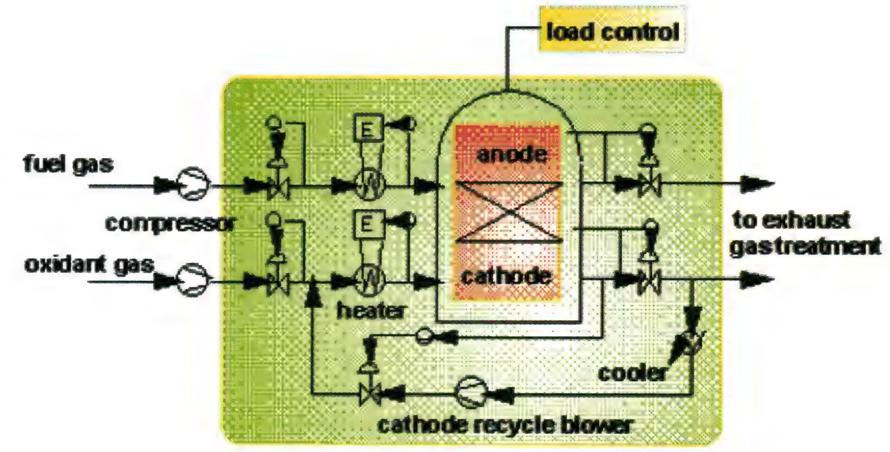
The phosphoric acid fuel cell (PAFC) is the most commercially developed type at present. It is being used in a variety of stationary applications for medium scale power generation and CHP, and is also suitable for larger vehicles such as buses and railway locomotives. The operating temperature range is higher than the two previous types at 160-220°C. This higher temperature produces steam that can be used for cogeneration of electricity, which roughly doubles the efficiency to about 85%.

The electrolyte is orthophosphoric acid. The cell is similar in operation to the PEM: hydrogen ions and electrons are produced at the anode, the ions travel through the electrolyte where they recombine with the electrons that have travelled via the external circuit, they mix with the oxygen and produce water (Figure 7). The cells can use hydrogen that is contaminated with carbon dioxide, so that the hydrogen can be produced from various fuels - they can also be used for direct methanol applications.

Molten Carbonate Fuel Cell

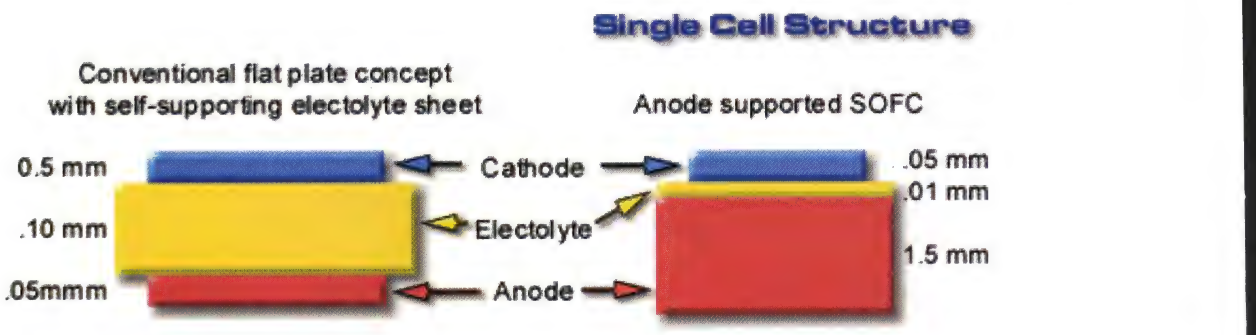
The molten carbonate fuel cell (MCFC) takes a jump up the temperature scale to around 650°C. And has an operating efficiency of 50-60%. It is being used for medium to large-scale power generation and CHP, including local and larger power stations.

The electrolyte is molten potassium lithium carbonate. Because of the higher operating temperature the cell can run on a mix of hydrogen and carbon monoxide from fossil-based fuels. This combines with the carbonate electrolyte, and then with the



A Simplified Diagram of A MCFC Operation Facility

Figure 8.



Figures 9a & 9b.

oxygen to produce water vapour and carbon dioxide (Figure 8).

Solid Oxide Fuel Cell

Right at the top of the fuel cell temperature scale is the solid oxide fuel cell (SOFC), with a range of 800-1000°C. It is the least developed type, but has the potential to provide stationary applications from small to large; and to be used for auxilliary power in vehicles with internal combustion engines, as well as recharging the batteries in a hybrid electric vehicle. The fact that the SOFC can operate using a wide variety of fuels - natural gas, propane, petroleum, etc - adds to its versatility. This is possible because it is the oxygen ion that migrates through the electrolyte, rather than the hydrogen ion, giving a greater choice of chemical to be oxidised. An additional advantage of the SOFC is that the high operating temperature allows the SOFC to directly reform the fuels.

The electrolyte is an ion-conducting oxide, such as zirconia treated with yttria. The electrodes are also ceramic, with nickel for the catalyst. A combination known as the ceramic PEN element (positive electrode, electrolyte, negative electrode). The 'traditional' type of SOFC is known as 'electrolyte supported' (Figure 9a) with a thick electrolyte and thin anode and cathode layers; this requires operating temperatures to be at the upper end of the range, which increases material and production costs. A recent alternative is the 'anode supported' type (Figure 9b). Here a thick anode provides the supporting structure and the electrolyte and cathode are thin, allowing reduced operating temperatures, reduced production costs and increased life. Other configurations have also been developed, with their own advantages and disadvantages.

Fuel is supplied to the anode where it undergoes an oxidation reaction, and releases electrons to the external circuit. O the cathode, oxygen becomes reduced by taking electrons from the external circuit. The electrolyte, which separates the two g compartments, conducts only oxygen ions from cathode to anode - which combine with the hydrogen to produce water and heat. As with the molten carbonate type, th cell exhausts water vapour and carbon dioxide. Its efficiency varies between 45-60%

Regenerative Fuel Cells

Those are the basic types of fuel cell. However, the fuel cell process is basically electrolysis in reverse, and it is possible to make a cell that can operate in both modes (Figure 10- a, fuel cell mode; b, electrolysis mode). Applying electricity to the cell's electrodes produces hydrogen and oxygen gases from retained water; these are then stored under pressure until they are required to power the cell again. Regenerative fuel cells (RFC) are usually combined with solar panels.

The electrolysis of hydrogen is being promoted on a much larger scale in California, with Hamilton Sundstrand Space Systems International and HyGen Industrie signing a Memorandum Of Understanding to develop and commercialise renewable hydrogen generation and vehicle fuelling systems using water electrolysis powered by sun, water and wind. Sun alone is being used by the Solar Hydrogen Energy Corporation - concentrated by reflectors, the heat is apparently sufficient to produce hydrogen and oxygen. As an alternative, scientists at the University of California have persuaded algae to produce hydrogen gas by keeping them in an anaerobic environment. Just some of the ways that hydrogen might be produced for fuel cells.

And there is going to be a lot of it required if fuel cell powered electric cars are going to be accepted in the next few years. All the major car manufacturers are developing prototypes (Figure 11). Generally obtaining the fuel cells from specialist companies, such as the Canadian Company Ballard Power Systems - which has been particularly active in supplying its PEM

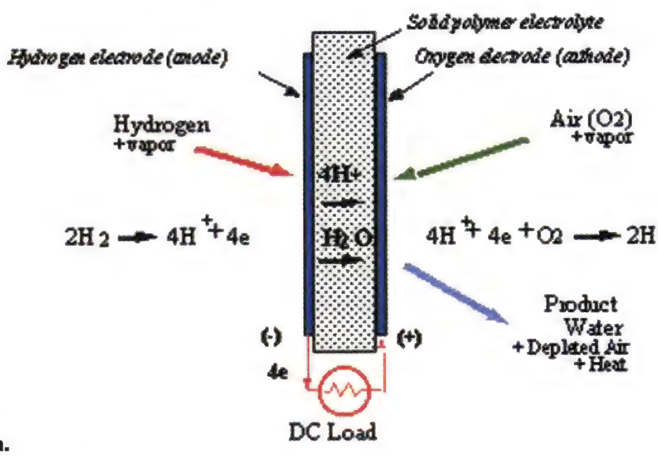


Figure 10a.

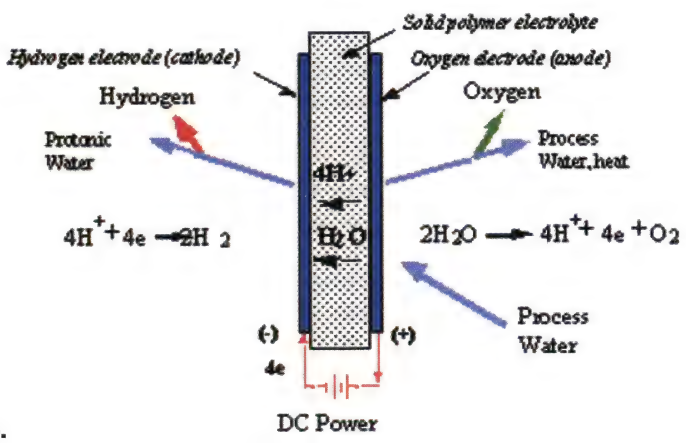
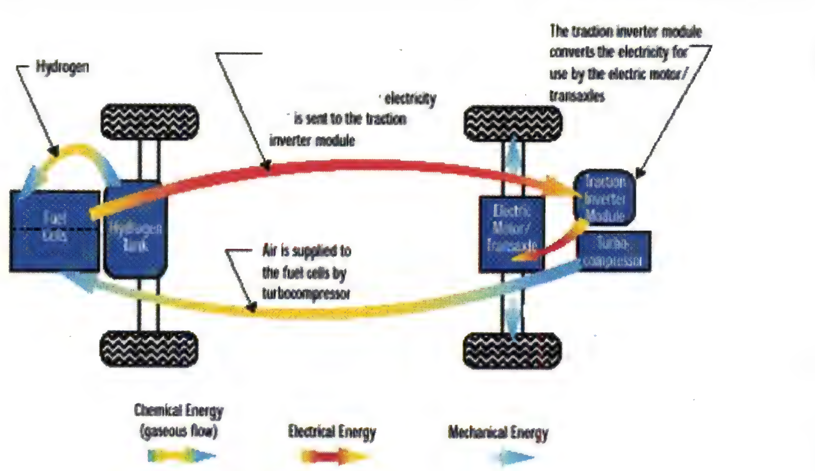


Figure 10b.


Hydrogen
electricity is sent to the traction inverter module
The traction inverter module converts the electricity for use by the electric motor/transaxles
Fuel Cells
Hydrogen Tank
Air is supplied to the fuel cells by turbocompressor
Electric Motor/Transaxle
Traction Inverter Module
Turbo-compressor
Chemical Energy (gaseous flow)
Electrical Energy
Mechanical Energy

igure 11.

lls for cars. Fuel cell powered cars have a rformance and range more closely proximating that of conventional cars an do battery powered ones, because fuel lls are generally more efficient for a given e and weight.

On a much smaller scale, researchers at se Western University have developed a el cell with a volume of just 5m^3. This has en achieved by printing layers of mponents onto a substrate. A hydride is ed at present, but methanol is planned for e future. Los Alamos National Laboratory d Motorola have designed a methanol el cell that is small enough to be used for mobile phones. The methanol would be made available in small, plug-in cartridges. Staying on the subject of mobile phones, Manhattan Scientifics recently acquired the rights to the MicroFuel Cell being developed by Energy Related Devices. They plan to launch it next year as a holster which will take the mobile phone and constantly recharge its battery (replacing the battery will come later), with a methanol cartridge to fuel it.

Try It Yourself!

If all this has got you interested in fuel cells you can obtain an experimenters kit from Electro-Chem-Technic (Figure 12). The URL is **www.i-way.co.uk/~ectechnic/**; or they can be e-mailed at: ectechnic@patrol.i-way.co.uk. You can also make your own fuel cell: J. Bull Electric has the details at **www.bull-electric.com** (workshop facilities are required, so it is not a project for beginners).

We shall have to wait and see whether we are on the verge of a fuel cell future or not. A lot of money is being put into the technology, so I cannot imagine it going to waste.

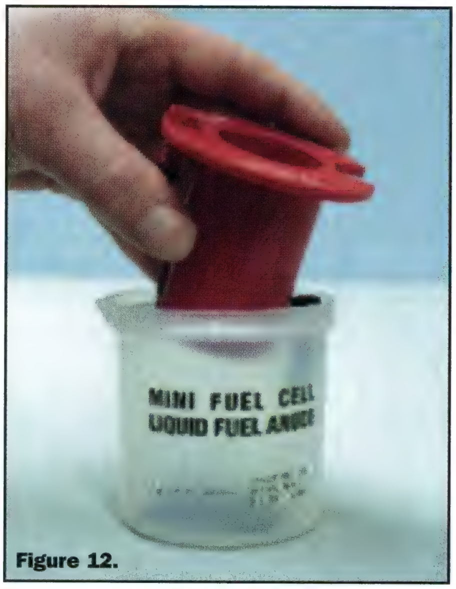


Figure 12.

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Evolvable CIRCUITS

This month Mike Bedford looks at 'Genetic Algorithm', a phrase well known in software engineering - but what does it mean?

Genetic Algorithms

In the realm of software engineering, the phrase 'genetic algorithm' is well known. Although it would be wrong to suggest that the technique is now in widespread use, there's been much research into genetic algorithms and a reasonable amount of press coverage. Such software is developed in a manner that mimics biological reproduction and the Darwinian theory of evolution by natural selection.

The basic principle is that the exact operation of a piece of software depends on various parameters or genes. Each gene controls a particular aspect of the software's operation and the sum total of all the genes is referred to as a chromosome. Initially the chromosomes are set randomly, the software is run, and a score is compiled to indicate how successful the software had been at accomplishing its task. This is repeated a number of times and the top two chromosomes, perhaps, are singled out. Now, the chromosomes of the two leading programs are combined in a way that is akin to breeding in biological organisms. In other words, combining the genes of the 'parents' in different ways creates a number of new chromosomes. Specifically, a technique called 'crossover' (see Figure 1 for a clarification) is used in which the two chromosomes are split at a random point - albeit on a gene boundary - and the two broken chromosomes spliced together. And occasionally, random mutations - flipping individual bits (see Figure 2) - are forced, once again, to mimic biological processes. Programs with these new chromosomes a then run and the process is repeated for another generation. The process stops when the score indicates that a solution ha been achieved or the experiment is abandoned. This cycle is shown as Figure 3

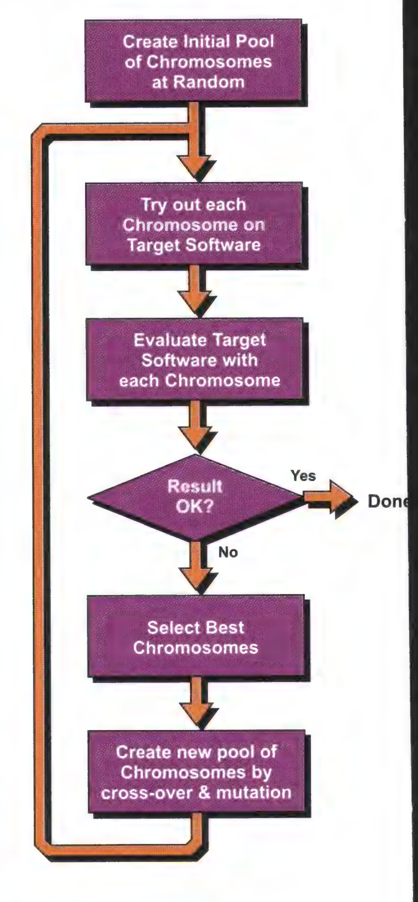

Create Initial Pool of Chromosomes at Random
Try out each Chromosome on Target Software
Evaluate Target Software with each Chromosome
Result OK?
Yes
Don
No
Select Best Chromosomes
Create new pool of Chromosomes by cross-over & mutation

Figure 2.

A few words of explanation about crossover and mutation are appropriate. Whereas the rationale behind the crossove is fairly easy to appreciate - to produce a hybrid of the two parents - the reason for mutation might not be quite so obvious. The philosophy is that this allows, during the evolution process, genes that hadn't been represented in the initial random sample to be tried out. Clearly it is a rando process and the result could be disastrous, indeed if too high a proportion of mutatio is allowed then almost definitely the result will be catastrophic. However, a small amount of mutation can have a beneficial impact on the evolving software.

The results have been impressive both a a demonstration level and in real world applications. Demonstrations are often of the A-life or artificial life type. For example, A-life organisms, each represented by a dot on the screen, are placed on a grid containin a replenishable food source. The organisms will consume any food they come across, breed to produce a new organism if they encounter a mate, and eventually die, their life duration depending on their success at finding food and various other factors. Genes control characteristics such as the organism's speed of travel, its eyesight (i.e. the distance over which it can see food or a

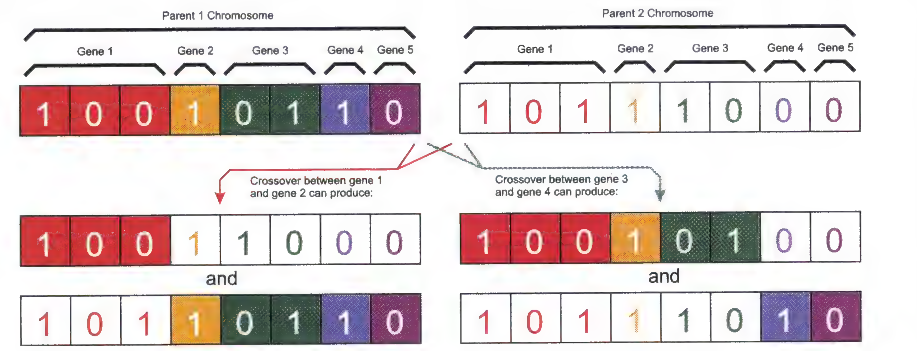


Figure 1.

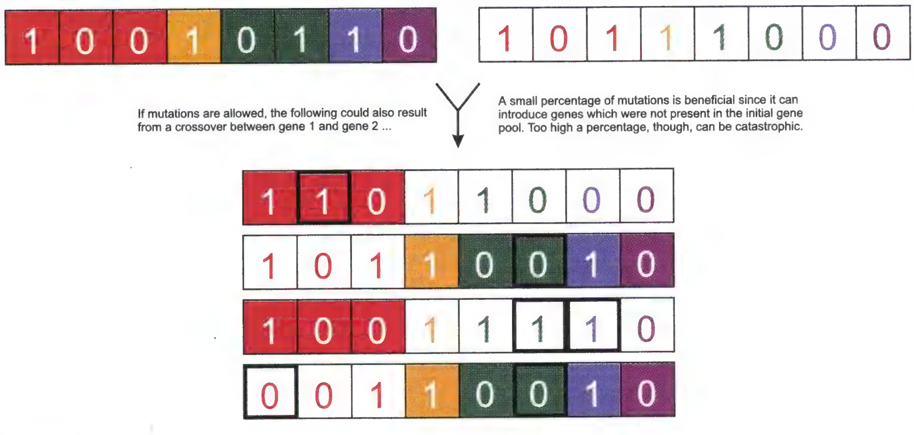

1 0 0 1 0 1 1 0
1 0 1 1 1 0 0 0
If mutations are allowed, the following could also result from a crossover between gene 1 and gene 2 ...
A small percentage of mutations is beneficial since it can introduce genes which were not present in the initial gene pool. Too high a percentage, though, can be catastrophic.
1 1 0 1 1 0 0 0
1 0 1 1 0 0 1 0
1 0 0 1 1 1 1 0
0 0 1 1 0 0 1 0

Figure 2.

Figure 4.

tential mate), its general state of health nd hence its life duration), and its otivations (e.g. whether it moves toward away from food, and whether it moves ward a potential mate or is repelled by e). After a period of evolution, the vast ajority of organisms are the ones with ourable genes, i.e. ones which allow a asonable speed of motion, good eyesight, d a sensible motivation, that is being awn toward rather than away from food d a mate.

earching the Gene pace

is sort of program, of course, is just a oof of concept and, in the simplest of ses, it is perfectly obvious what mbination of genes would give the A-life ganisms the best chances of surviving and ssing their genes on to the next neration. In reality, of course, genetic gorithms would be used in applications here it's far from obvious how a particular problem should be solved. Furthermore these will be applications in which the number of parameters is large, the number of combinations huge, and the time taken to try them all out in sequence would be prohibitive. By their very nature, though, genetic algorithms perform a directed search through the gene space and hence can often come up with an acceptable solution in a reasonable time period. Some of the best known examples of genuine applications have been in the arts. Computer artist William Latham, for example, specialises in visualising other-worldly life forms and has exhibited his work in prestigious galleries world-wide. A classic example of his work is shown as Figure 4. The life forms are generated automatically using software written by the artist in which the characteristics are defined by parameters or genes to use the biological parallel. But the number of genes and their permissible values are such that searching through them using conventional techniques would be prohibitive. And since the visual effect of genes in combination is not always obvious, pleasing works of art could remain hidden forever. Latham has solved this problem using his Mutator program. A selection of random life forms is displayed on screen and the artist selects the two that he finds most aesthetically pleasing. The chromosomes of these life forms are then used as the basis for the next generation and the process continues until a final result is achieved. Latham has now turned his attention to computer games and is using genetic algorithms to control the action of characters within the games. His first game to employ genetic techniques is called Evolva and has just been released by Virgin Interactive **(www.viw.co.uk)**. Figure 5 is a screen shot from this game and whereas this might look like any other action game of the shoot 'em up genre, the game play is, apparently, quite different due to the use of the genetic algorithm engine.

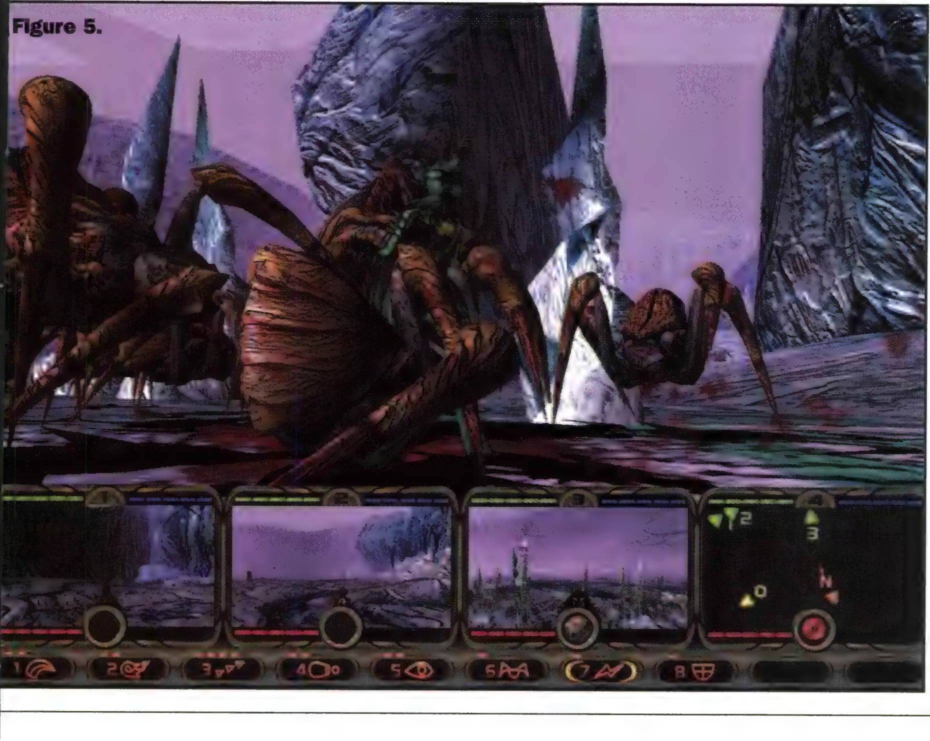


Figure 5.

So far we've looked at applications where the basic algorithm is known and evolvable chromosomes are used to fine tune the operation. However, there are problems in which nobody has even managed to figure out what the basic structure of the algorithm should be. And in this case it's clearly not possible to write a program for which a genetic algorithm simply optimises various parameters. However, a similar technique has been used in which the actual algorithm, and not just the parameters, is allowed to evolve. Clearly this isn't achievable with a conventional computer program. Although a program is a sequence of zeros and ones, this really can't be likened to the chromosome that we've talked about. Instead these zeros and ones correspond to instructions that are executed in sequence, and any attempt to perform a crossover, let alone a mutation, on two programs would, more than likely, produce a program which would crash at some point. Even if, by some coincidence, a valid program resulted, its operation would almost certainly not be a better solution than its parents. Instead, a so-called classifier system has to be used to allow evolution. This is a system in which the logic is represented by a string of ones and zeros but these ones and zeros aren't the op-codes of instructions that are executed in order. Instead, the ones and zeros represent how the system should respond to particular combinations of its inputs. This is too complicated a subject to describe fully in this brief introduction but, suffice it to say, any program which could be written in a conventional computer language such as Basic or C, could be re-written as a classifier system. Since the operation of the system is controlled entirely by that sequence of ones and zeros, this code can be considered the system's chromosome and our technique of breeding the most successful systems by crossover and mutations can be applied.

One particularly successful application of an evolved algorithm using a classifier system was devised in the University of Illinois for the control of a gas pipeline. This is an example of a control system for which manual operation had previously been the only solution. But even this was by no means easy, primarily because of the long time lag between making a change and the effect of that change becoming evident. This just wasn't intuitive so operators required a long apprenticeship in order to master the system. The fact that genetic algorithms have proved successful is particularly interesting since evolving the algorithm is a close analogy to the training of human operators - the only other option that is currently viable.

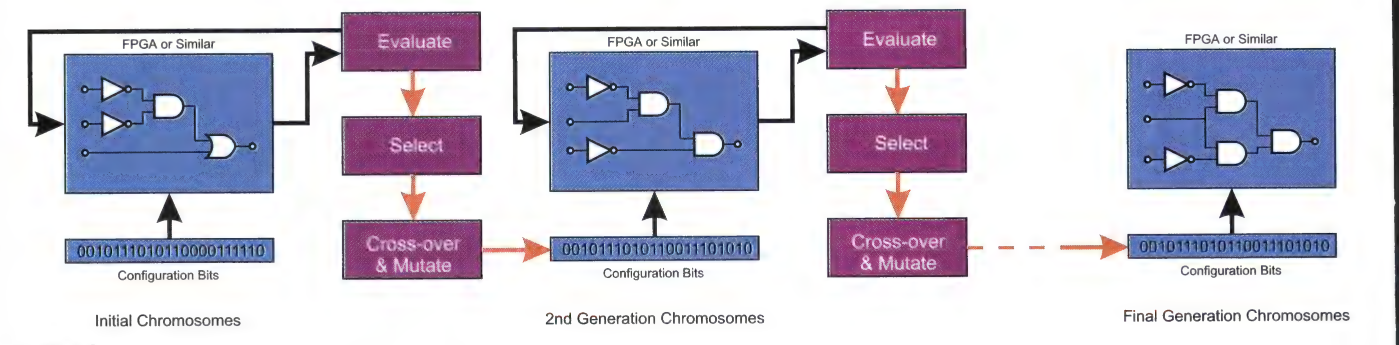


Figure 6.

Evolvable Circuits

OK, that's as much as I intend to say on genetic algorithms - that is software that can evolve. This was really just to set the scene for the main subject of this article, the lesser-known field of evolvable hardware. Increasingly, equipment is being designed so that its function is not set in concrete the moment it leaves the production line. A classic example is anything containing a microprocessor. By changing the software stored in ROM new features can be added, and if flash memory is used then this upgrade can be carried out by the end user. But it's important to stress that this is changing the software (well, firmware actually) rather than hardware and there's a limit to how much can be achieved with changes to the software alone. But upgrades to the hardware are also possible if use is made of reconfigurable components such as field programmable gate arrays or FPGAs (see box out for details) and, once again, this would allow the end user to upgrade the equipment.

Impressive as all this may sound, though, this is not what is meant by evolvable hardware. In order to upgrade a piece of equipment containing an FPGA an electronic design engineer first has to figure out how the circuitry should be changed. If the new functionality is to be made available to existing customers, the new configuration then has to be distributed and the customer has to follow the upgrade procedure. However, to quote Xin Yau of the University of Birmingham and a pioneer in the field, "Evolvable hardware refers to one particular type of hardware whose architecture, structure and functions change dynamically and autonomously in order to improve its performance in performing certain tasks.". Note his use of the word autonomously - this is hardware that reconfigures itself. Note also Yau's use of the word dynamic, even though other researchers also talk about a slightly different concept - that of static evolvable hardware. In the static approach, the iterative process required to automatically generate the required functionality is performed as part of the design process. And once the circuit leaves the factory its functionality is fixed. With dynamic evolvable hardware, on the other hand, the evolution continues when the product is in use. As conditions change, therefore, the hardware reconfigures itself to cope with the changing environment and so ensures continued optimum performance. Figure 6 shows the iterative cycle of evolvable hardware and this is clearly very similar to the way in which the evolvable software operates. In static evolvable hardware, the processor that runs the genetic algorithm is external to the final product, in dynamic evolvable hardware it is integral.

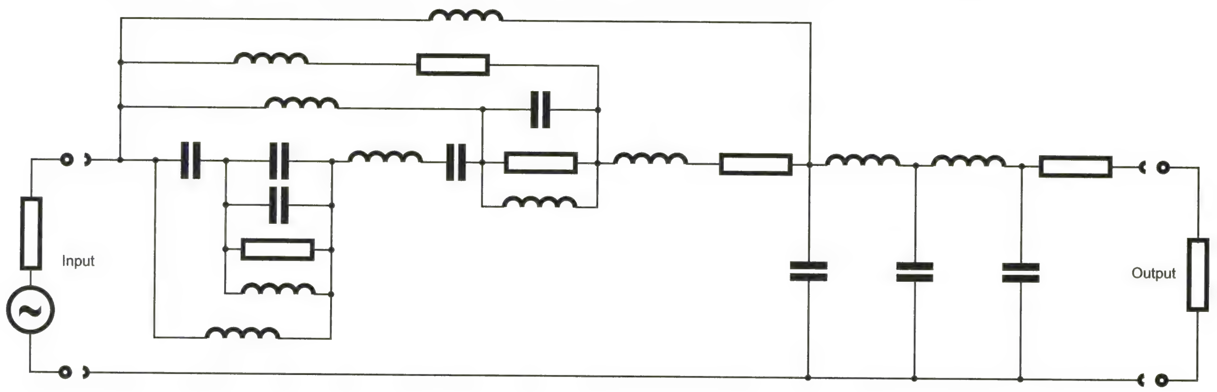
Success Stories

Let's now jump straight in by looking at some success stories - some applications in which evolvable hardware has already reaped benefits or in which research is looking promising. In the main, these applications involve allowing the circuit to evolve within an FPGA although analogue evolvable hardware, which can't make use of the essentially digital nature of the FPGA, has also been produced.

Tetsuya Higuchi, of the Evolvable Systems Laboratory at MITI's Electrotechnical Laboratory in Japan has developed a chip with evolvable hardware to handle data compression and decompression in top-end colour printers used in the printing and publishing industries. These printers typically output to A4 at 1200dpi with a throughput of 100 pages per minute, thereby requiring data transfer at a rate of 300MB/s, significantly in excess of that achievable from standard hard disks. Data compression is, therefore, integral to the operation of such a printer, but conventional software techniques are not able to provide either the necessary speed or the compression ratio. Conventional hardware, on the other hand, is faster but is even less flexible and therefore achieves an even lower compression ratio. Clearly a hardware solution is needed but only by using evolvable hardware can the necessary flexibility be provided. Whenever the compression ratio falls, due to changes in the types of pattern in the document being printed, the circuitry reconfigures itself to improve its performance. Results have been encouraging - the compression ratio achieved is almost double that obtainable using conventional software compression algorithms and, furthermore, the necessary speed of operation has been reached. The chip - which contains both the reconfigurable hardware and a 32-bit RISC processor which runs the genetic algorithm - is going into production for use in commercial printers.

A major research project undertaken at NASA's Jet Propulsion Laboratory and elsewhere involves the development of fault-tolerant hardware for use in deep space probes. The electronic equipment used in missions to the outer edges of the Solar System and beyond may be require to operate for decades yet the environme in which it's placed really isn't too conducive to long-term operation. The hardware is subject to ageing, to wide temperature variations and, perhaps most importantly, to ionising radiation which ca cause permanent damage to individual elements within integrated circuits. One common conventional approach to fault-tolerance is to provide redundant circuitry circuitry that, under normal circumstances plays no part but which is switched into circuitry should a fault occur. Needless to say this is an expensive proposition. Not only does this impose a cost associated wi duplicating all the critical systems, but the increased size and weight of the hardware will also impact the size of the vehicle and hence the launch and operational costs to The hope and expectation is that evolvabl hardware will be able to provide an acceptable level of fault-tolerance without going to the expense of duplicating everything. Perhaps the most obvious way of achieving fault-tolerance is to use evolvable hardware dynamically. And although some groups are working on this solution - causing the circuitry to reconfigure itself on the fly as and when faults occur - the major drawback is the ti taken for a repair to be effected. Unlike those dynamic evolvable circuits that are designed to reconfigure themselves under gradually varying conditions, a fault is a ste function that could result in many thousands of iterations before a new solution is obtained. Clearly this would result in a long down time. The alternative approach is to use the evolvable approach statically in order to design a circuit that ha an inherent immunity to faults. The drawback here is that the circuit will only b guaranteed to show tolerance to particular faults - the ones that were injected during the training process. Some researchers are attempting to improve on this technique b using a pair of genetic algorithms - one to optimise the circuit to cope with faults and the other to devise faults to try to catch ou the evolving circuitry. This has been described as the 'arms race' approach to fault tolerance.

The applications of evolvable hardware which we've seen so far are ones in which the entire circuit topology is allowed to grow using a non-committed, programmabl integrated circuit such as an FPGA or a FPT (field programmable transistor array). However, useful results have also been



igure 7.

ieved by using genetic algorithms to fine e circuits with a fixed topology. This is pecially common in analogue electronics - example, the RF circuitry used in mobile ones. In another project at MITI's olvable Systems Laboratory, evolvable rdware is being used for IF filters, mponents which need to adhere to very ht tolerances. Because of variances during manufacturing process, the nventional approach is to test all the vices coming off the production line and card those which are outside of their ecification. This is a wasteful process. The ip developed to overcome this problem ntains 39 transconductance amplifiers ose characteristics can be set genetically. e chip went into production in late 1998 sulting in a dramatic increase in yield. spite the fact that each amplifier may fer from its target value by up to 20%, and spite the fact that a 1% error in the filter's ntre frequency is unacceptable, evolution s allowed 95% of all chips manufactured meet the overall specification.

esigning by Evolution

far we've looked at evolvable hardware, at is, hardware such as the FPGA in which e functionality can be controlled or odified automatically either at the anufacturing stage or during operation. osely related to this is the work being rried out by Jason Lohn and others at NASA's Ames Research Center. Here, hardware which, in itself, is reconfigurable isn't employed. Instead, standard hardware consisting of ordinary resistors, capacitors, inductors and transistors is used, but the way in which those components are connected together is determined by genetic algorithm software. The rationale here is different. Clearly this approach doesn't permit a piece of equipment to adapt to changing conditions, nor does it allow different products to be generated from the same basic hardware, simply by using a different goal to configure the circuit at the design stage. The reason for experimenting with automated design is simply that analogue design engineers are now so thin on the ground, despite the fact that the majority of products still require some analogue circuitry.

The design system has three basic elements. First of all there is the circuit builder which configures the topology of the circuit depending on the parameters fed to it. These parameters include the type of component (i.e. transistor, resistor, capacitor, inductor etc.), its value, and how it should be connected (e.g. to ground, to the supply rail, to a previous node, or to a new node). Secondly there is an analogue circuit simulator such as SPICE that determines what output the circuit would produce for a given set of inputs. And finally there is the genetic algorithm engine that compares the simulation results of each circuit with the design goal and generates the parameters for new circuit variations based on a success score and the principles of crossover and perhaps mutation. Let's now look at a couple of the circuits that have been designed using this novel approach.

The first circuits to be evolved were passive filters. These were chosen as a first step since they used just two-terminal devices - i.e. resistors, capacitors and inductors, they had no power connections, and filter design is well-understood and documented. In one exercise, the design of a low-pass filter, the specification called for a cut-off frequency between 1kHz and 2kHz, a pass-band attenuation of 0.01dB, and a stop-band attenuation of 60dB. Figure 7 is the circuit that has been produced using the system, and Figure 8 compares the actual performance of the filter with the target characteristics. The circuit that achieved these requirements evolved after about 930,000 circuit evaluations taking many hours on six workstations. Having proved the system with passive filters, attention turned to amplifiers. Now, of course, transistors were needed with the added complexity of coping with 3-terminal devices and power supplies. Figure 9 is an 85dB amplifier that was produced and, as with the low-pass filter, the performance is acceptable.

According to Jason Lohn, the circuits are of about the standard that would be expected of a first year student on an electronic engineering course. However, the circuits certainly don't look like anything a first year student would have come up with, nor an experienced design engineer for that matter. In fact the circuit topology would be quite unrecognisable to an analogue design engineer. These unconventional circuits have some interesting properties. For a start, many of the evolved circuits will only operate over a narrow range of conditions. For example, some of them will work only within a narrow band of temperatures centred around the temperature specified in the simulation. Presumably the evolution process would have to be carried out over a wide range of temperatures in order to overcome this drawback. Another strange feature of many of the circuits is that they have redundant components. Basically the circuit will continue to operate correctly even if these extra components are cut out. Lohn explains this phenomenon by

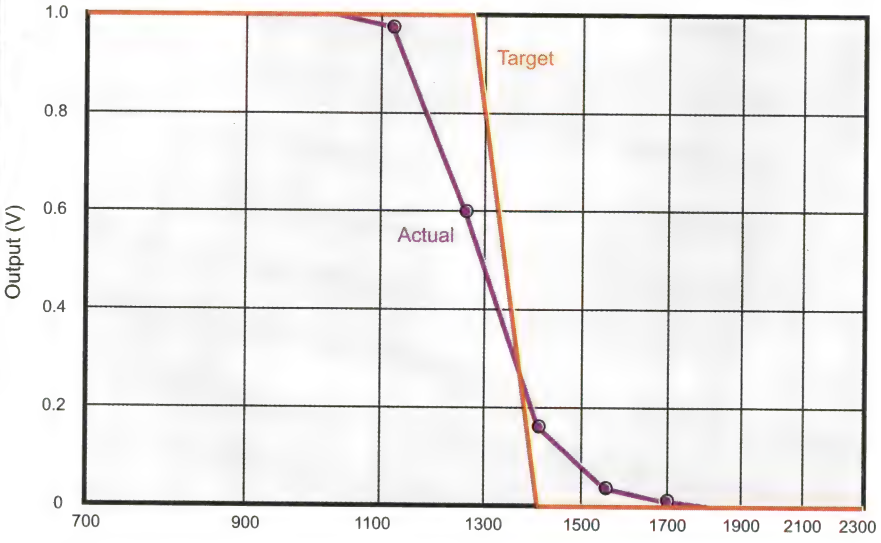


Figure 8.

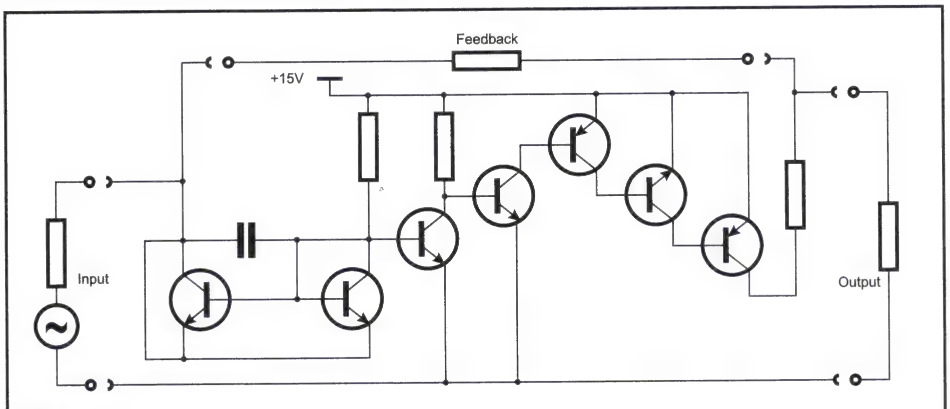


Figure 9.

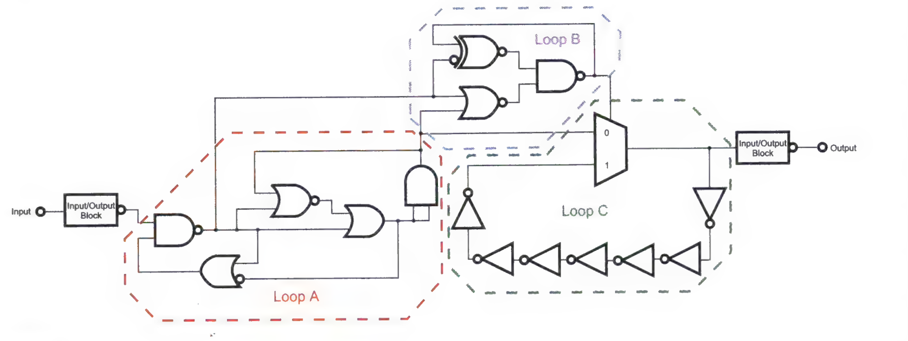


Figure 10.

describing the redundant components as the vestiges of evolution - elements that had originally served some purpose but which fell into disuse as better circuitry evolved. Clearly there are drawbacks of the evolutionary approach to designing hardware, but there are some potential strengths too - the circuit topology isn't constrained by conventional thinking. Instead, the system is allowed to search the whole of the gene space and can, as a result, come up with some truly innovative solutions, solutions that, in some cases, might outperform conventionally designed circuits.

How Does It Do That?

Despite the fact that the analogue circuits developed by a genetic algorithm in the previous section were described as quirky, any competent analogue design engineer would recognise that the circuits will, indeed, do what they purport to do. To put it another way, the circuits are easy to analyse even though they're somewhat unconventional. But the same isn't true of all evolved hardware.

In an exercise carried out by Adrian Thompson and Paul Layzell at the University of Sussex's School of Cognitive and Computing Sciences in Brighton, a circuit was evolved on an FPGA to differentiate between two frequencies - specifically audio tones of 1kHz and 10kHz. The researchers were interested in how an FPGA - normally considered a logic device - could be pressed into service for continuous time problems. The hardware was allowed to evolve in a 10 x 10 cell corner of an FPGA and a working circuit emerged using just 16 of the cells - far less hardware than was expected from a knowledge of conventional circuits. The $64,000 question, though, is "how does it work?" - a question which still hasn't been adequately answered. Indeed some characteristics of the circuit are bizarre. Figure 10 is a circuit diagram of the evolved circuit. It's shown as a collection of logic gates although the researchers point out that "the system's behaviour is unlikely to be fully captured by this Boolean level of extraction". Not shown on this diagram are a number of cells that, although not connected to the main part of the circuit, affect its operation. Specifically, if the outputs of these cells are clamped then the circuit behaves less reliably. The mechanism by which these cells affect the circuit has yet to be discovered. But this is just one of the mysterious aspects of the circuit. Tests have proved that the loops indicated A and B on the circuit diagram lock into an inactive state within 20nS of the start of a high going pulse. Nevertheless, as the input pulse returns to the low state, the circuitry which had been inactive is able to generate a correct output depending on the width of the positive going pulse - i.e. the frequency of the input tone. Researchers have described this as "astonishing".

So we have a circuit, utilising just 21 ce of an FPGA which, so far, has defied analy And even if this circuit eventually gives up its secrets, what of more complicated evolved circuits? It seems highly likely tha large proportion of future evolved circuit will defy all attempts to understand their workings. And this is a cause of some concern to many of those working in this field. Does it really make sense to rely on circuitry that we can't understand? You might take the view "if it works then why not?" and at first sight this seems reasonable. However, how can anyone know if it works - under all conditions, th is. With no knowledge of how the circuit supposed to work the only information available is empirical. In other words, all t can be guaranteed is that the circuit will work under the conditions it was tested under. For circuits with large numbers of inputs, though, it just won't be feasible to test it under all conceivable conditions an so there will remain nagging doubts as to whether the circuit will produce some na surprises. In fact, this is already true of complex conventional circuits, for exampl the Pentium processor - hence the infamo bug.

Hands-on

If you fancy getting a bit of hands-on experience with evolvable circuits, Paul Layzell has designed something he calls a evolvable motherboard and has made the circuit diagrams, PCB layout and software available on the Web. The board is shown Figure 11 and Figure 12 is a block diagram illustrating the principle of operation. Basically, the motherboard is a large array programmable switches which are controlled by a PC. Daughter boards

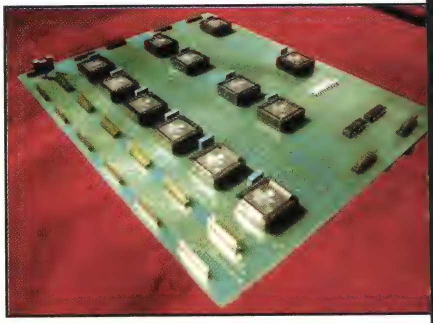


Figure 11.

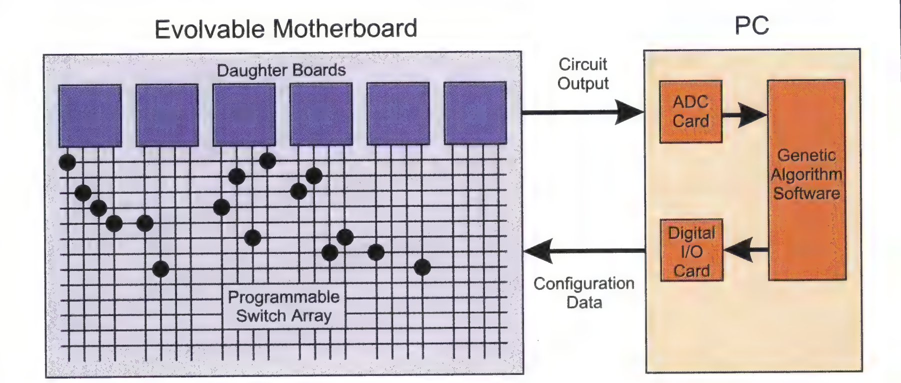


Figure 12.

gged into the motherboard are erconnected by the programmable tches. The daughter boards can contain a le range of electronic building blocks h as transistors and op-amps so the end ult is that these components are nnected together dynamically under the ntrol of a PC. And, unlike FPGAs, all the s are accessible with test equipment so t the evolved circuits can be fully lysed. For full details, take a look at **tp://www.cogs.susx.ac.uk/users/paul /Motherboard/motherboard.html.** There lso a possibility that PCBs may be ilable - contact Paul at lla@cogs.susx.ac.uk if you're interested.

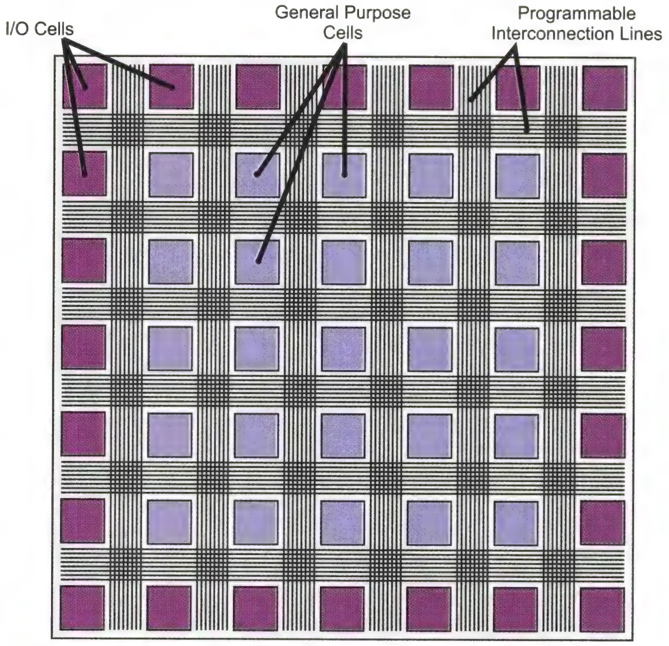
eld Programmable ate Arrays

e Field Programmable Gate Array or GA is a vital element of many evolvable cuits. However, since it's rarely used in me construction or in low complexity nufacturing, it will undoubtedly be familiar to some readers. This, therefore, brief introduction to FPGAs, describing at they are and how they're used.

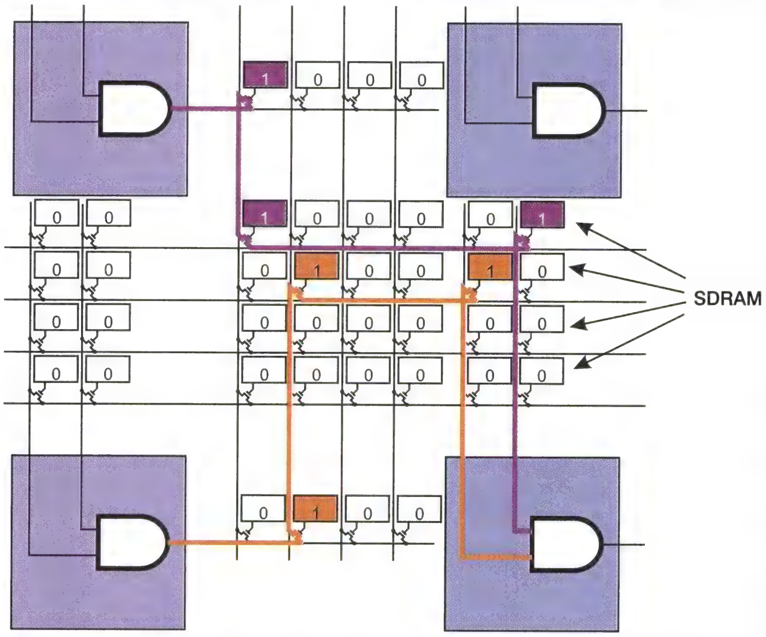
f you have a need for a VLSI (very large le integration) chip to perform some ecific non-standard job there are two sic approaches. Either you have a custom ip made or you programme a general-rpose programmable chip. The first tion involves a massive up-front cost but e unit price is low whereas the second tion uses more expensive components t obviates the need to pay a semiconductor anufacturer that initial design and tooling st. The upshot of all this is that custom ips are economically viable only for large lume production whereas programmable vices are feasible in much more modest oduction runs. The programmable proach also provides more flexibility in at changes to the functionality can be ade without redesigning the hardware.

e FPGA is a programmable device and has e additional advantage that it can be re-ogrammed in the field. In fact, the FPGA an extension to the masked gate array - a pe of chip that comes somewhere tween the full custom and the ogrammable approaches. Whereas a full stom chip requires every single mask in e chip to be defined, in the masked gate ray - an example of a semi-custom device - ly a single interconnect layer is defined by e customer and so those up-front costs e reduced. The basic chip onto which the stomised interconnect layer is applied is a ge array of uncommitted logic - the ansistors needed to implement logic ements such as inverters, OR-gates, AND-tes and the like. By applying the stomised interconnect layer, the dividual circuit elements are configured cording to the specific requirements and nnected together to make a working rcuit. The FPGA is similar except that in ace of the interconnect layer is an array of ectronic switches which can be turned on off by programming, just as memory cells n be configured to the 0 or the 1 state in a ash memory chip. These electronic witches make connections between the uncommitted logic, thereby configuring them to perform a specific task. Since some FPGAs allows the circuit configuration to be redefined a large number of times, they're suitable for implementing evolvable circuitry.

Figbox 1.



Figbox 2.



The first illustration shows the basic structure of an FPGA. You'll notice that there are, in fact, two types of cells, the general purpose logic cells in the centre of the chip and the I/O cells around the edge which connect to the pins. The second diagram shows rather more detail around a few cells in a simplified and rather simplistic manner. You'll notice that the configuration is achieved by writing to memory cells that control the switches at the intersections of the interconnection lines. A couple of interconnections are shown as made - these are the ones indicated by coloured lines. The corresponding memory cells have also been coloured. Real FPGAs can have millions of cells and hundreds of pins.

In conclusion it's worth pointing out some of the difficulties of using FPGAs for evolving circuits. For a start, not all use re-writable memory cells - some use antifuses so are configurable just the once. This is a parallel to the difference between a PROM and flash memory. Even if you get the right type of FPGA, though, it still isn't all plain sailing. Most of the currently available devices allow you to specify configurations that will blow up the chip (e.g. by allowing several tri-state devices connected to the same line to be active at the same time). To get round this, some manufacturers have proprietary validity-checking software but this slows down evolution considerably. Another solution is to encode the chromosome so that these configurations can't occur but this is by no means a simple task. All in all, therefore, evolvable hardware using FPGAs is not for beginners - take a look at Paul Layzell's evolvable motherboard instead.

Controlling DC Motors WITHOUT A SENSOR

A novel, method of controlling motors from ST Microelectronics and Kanda Systems

Electric motors are an essential component of our industrialised society with no less than 5 billion motors built worldwide every year. Brushless DC motors are already used in hard disk drives and many industrial applications, and their market share is growing significantly in automotive, appliance and industrial applications.

A suitable method of controlling brushless DC motors is with a microcontroller.

The ST72141microcontoller has been developed by STMicroelectronics to control synchronous motors or, more specifically, 3-phase brushless DC motors. The most common applications of this type of motor are industrial control, automotive equipment, refrigerators, air conditioners, compressors and fans, where brushless DC motors are already used due to their high efficiency, silent operation, compact form, reliability and longevity.

These devices are members of the ST7 microcontroller family designed specifically for motor control applications and includes an A/D converter and an SPI interface. They include an on-chip peripheral for control of electric brushless DC motor either in sensor or sensorless mode.

Brushless DC motors consist of two coaxial magnetic armatures separated by an air gap. In certain types of motor:

The outer part of the motor is called the stator and is fixed. The internal armature is the rotor.

In normal brush DC motors, the internal armature, the rotor, is an electro-magnet. This armature is supplied by a constant current (DC). In a Brushless DC motor, the rotor is a permanent magnet, this type of motor has almost the same properties and physical laws as a DC current machine. The external stator is polyphased using 3 phases in this case. The current pulses through these coils at a rate given by ω. As it is a synchronous motor then, if Ω is the angular speed of the rotor, we have the relation: $\Omega=\frac{\omega}{p}$, where p is the number of poles.

As we know an electric motor transforms electrical energy into mechanical energy and the two main characteristics of a brushless DC motor are:

1) It has an electromotive force proportional to its speed
2) The stator flux is synchronised with the permanent magnet rotor flux.

Using the back EMF (electromotive force) of the motor is the basis of one the ways of driving brushless DC motors with the ST72141 microcontroller in sensorless mode.

The ST72141 (ST7 Motor Control) is particularly suited to driving Brushless DC motors as it supports operating modes like:

- Commutation step control with motor voltage regulation and current limitation in Voltage mode
- Commutation step control with motor current regulation, i.e. direct torque control in current mode
- Sensor or Sensorless motor phase commutation in both delta and star connections
- Back-EMF zero-crossing detection with high sensitivity. The integrated phase voltage comparator is directly referred to the full back-EMF voltage without any attenuation. A clamping function is provided to protect the microcontroller). A back-EMF voltage down to 200mV can be detected (the detection threshold voltage can be selected from 4 different values: 0.2, 0.6, 1.2 and 2.5V) This provides high noise immunity and self-commutated operation over a large speed range Real tim motor winding demagnetisatio detection for fine-tuning the phase voltage masking time to be applied before back-EMF monitoring.
- Automatic and programmabl delay between back-EMF zer crossing detection and moto phase commutation.

The ST72141 is a very powerful and complete technical solution for driving brushless DC motors. It provides a complete digital solution, eliminating the need for analogue filters and potentiometric dividers.

Kanda Systems, a company known for their test and development kits have designed and manufactured the ST7 Motorcontroller development kit. At £435 this kit allows an engineer to learn about Brushless motor control with the supplied motor, test his own motor and even program the ST72141 device for use in real applications.

The kit includes a motorcontroller development board, programming boards, default 24V motor and power stage - which can support 12V-300V.

More details, including a working software download can be found on ST's engineering forum website: **www.st7-forum.com.** Also available here is the complete documentation on the ST72141 and a full range of Motor control application notes.

SCR Principles AND CIRCUITS

Ray Marston describes basic SCR principles and looks at practical SCR circuits in this special feature article.

An SCR (Silicon Controlled Rectifier) is a controllable medium- to high-power self-latching solid-state DC power switch. This article explains its basic operation and shows some practical ways of using it.

SCR Basics

An SCR is a four-layer pnpn silicon semiconductor device. It has three external terminals (anode, gate, and cathode) and uses the alternative symbols of Figure 1(a) and has the transistor equivalent circuit of Figure 1(b). Figure 2 shows the basic way of using the SCR as a DC switch, with the anode positive relative to the cathode, and the SCR controlled via its gate. The basic characteristics of the SCR can be understood with the aid of these diagrams, as follows:-

1. When power is first applied to the SCR by closing S1 in Figure 2, the SCR is 'blocked' and acts (between anode and cathode) like an open switch. This action is implied by Figure 1(b), i.e., Q2's base current is derived from Q1 collector, and Q1's base current is derived from either Q2 collector or the gate terminal; in the latter case no base current is available, so both transistors are cut off, and only a small leakage current flows from anode to cathode.

2. The SCR can be turned on and made to act like a forward-biased silicon rectifier by briefly applying gate current to it via S2; the SCR quickly (in a few microseconds) self-latches into the on state under this condition, and stays on even when the gate drive is removed. This action is implied by Figure 1(b); the initial gate current turns Q1 on, and Q1's collector current turns Q2 on, and Q2's collector current then holds Q1 on even when the gate drive is removed: a 'saturation' potential of 1V or so is generated between the anode and cathode under the on condition.

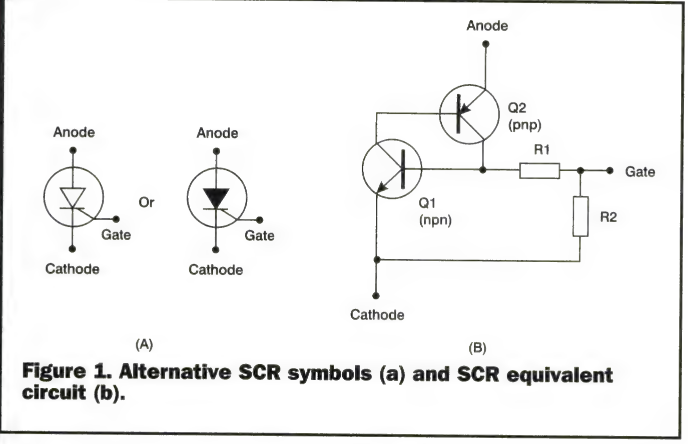


Figure 1. Alternative SCR symbols (a) and SCR equivalent circuit (b).

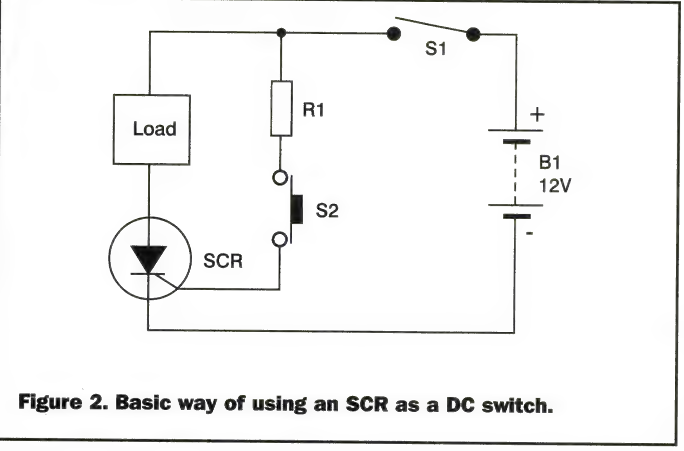


Figure 2. Basic way of using an SCR as a DC switch.

3. Only a brief pulse of gate current is needed to drive the SCR on. Once the SCR has self-latched, it can only be turned off again by briefly reducing its anode current below a certain 'minimum holding current' value (typically a few milliamps); in AC applications turn-off occurs automatically at the zero-crossing point in each half-cycle.

4. Considerable current gain is available between the gate and anode of the SCR, and low values of gate current (typically a few mA or less) can control high values of anode current (up to tens of amps). Most SCRs have anode ratings of hundreds of volts. The SCR gate characteristics are similar to those of a transistor base-emitter junction (see Figure 1(b)).

5. Internal capacitance (a few pF) exists between the SCR's anode and gate, and a sharply rising voltage appearing on the anode can cause enough signal breakthrough to the gate to trigger the SCR on. This 'rate effect' turn-on can be caused by supply-line transients, etc. Rate-effect problems can be overcome by wiring a C-R smoothing network between the anode and cathode, to limit the rate of rise to a safe value.

AC Power Switching Circuits

Figure 3 shows an SCR used in an AC power switching application; alternative component values are shown for use with 240V or (in parenthesis) 120V AC supplies. The AC power line signal is full-wave rectified via D1-D4 and applied to the SCR anode via lamp load LP1. If S1 is open, the SCR and lamp are off. If S1 is closed, R1-R2 apply gate drive to the SCR, which turns on and self-latches just after the start of each half-cycle and then turns off again automatically at the end of the half-cycle as its forward current falls below the minimum holding value. This process repeats in each half-cycle, and the lamp thus operates at full power under this condition. The SCR anode falls to about 1V when the SCR is on, so S1 and R1-R2 consume little mean power. Note that the lamp load is shown placed on the DC side of the bridge rectifier, and this circuit is thus shown for use with DC loads; it can be modified for use with AC loads by simply placing the load on

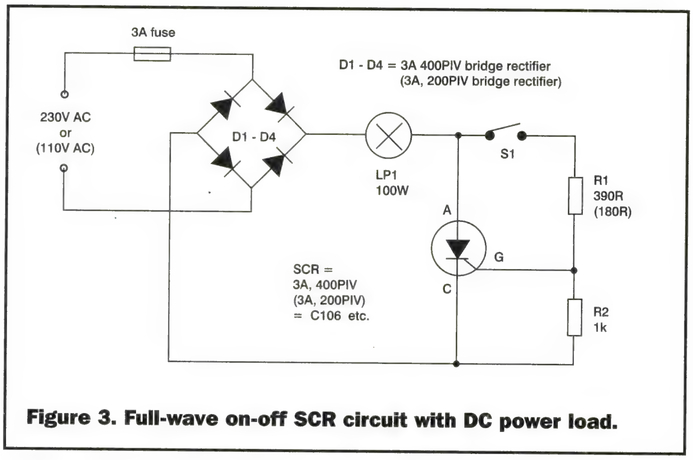


Figure 3. Full-wave on-off SCR circuit with DC power load.

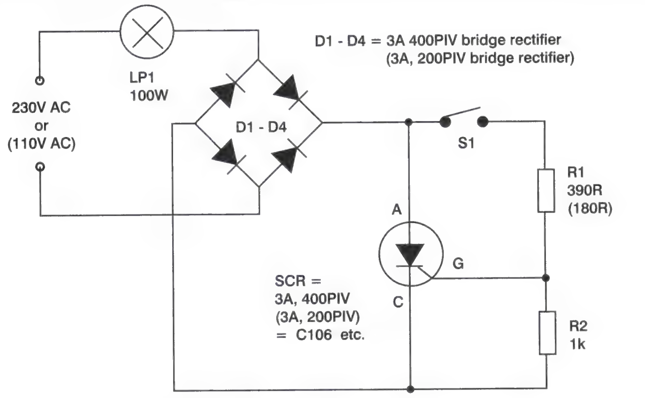


Figure 4. Full-wave on-off SCR circuit with AC power load.

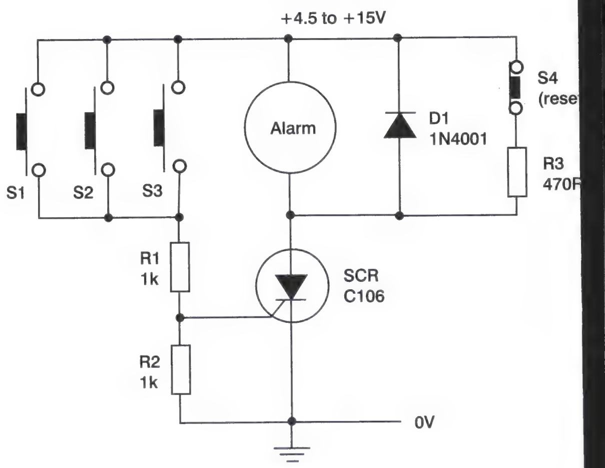


Figure 7. Multi-input self-latching panic alarm.

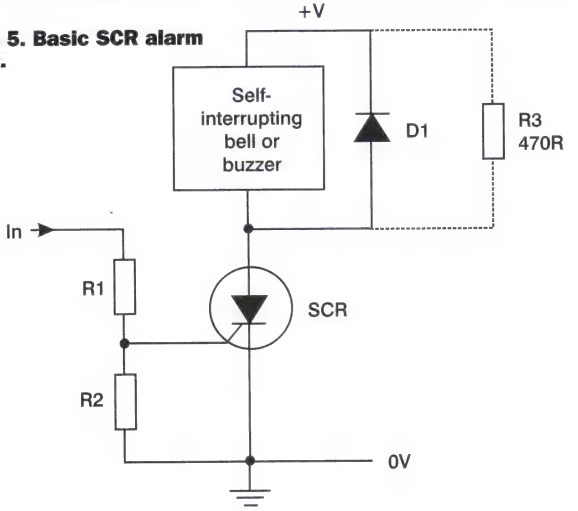


Figure 5. Basic SCR alarm circuit.

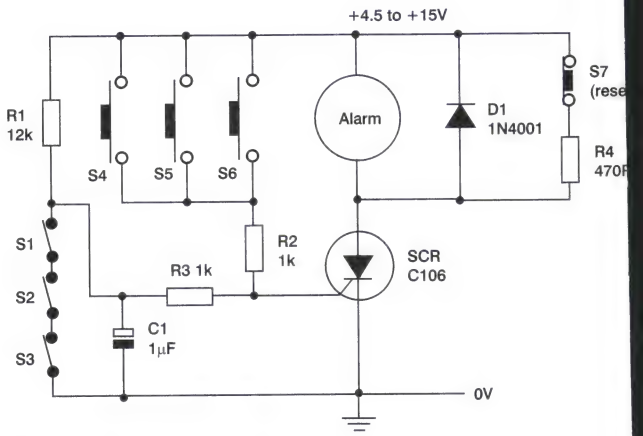


Figure 8. Simple burglar alarm system, with panic facility.

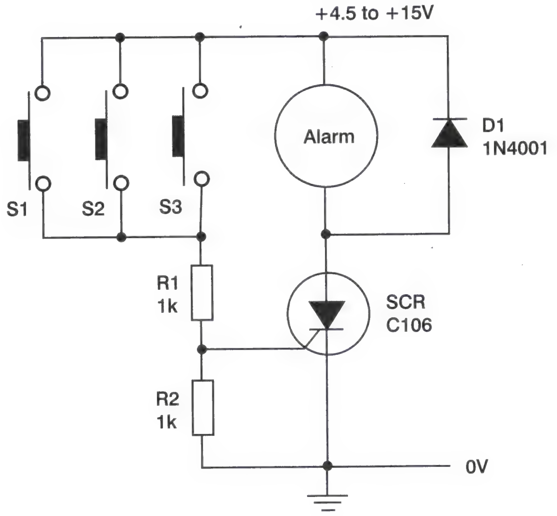


Figure 6. Multi-input non-latching alarm circuit.

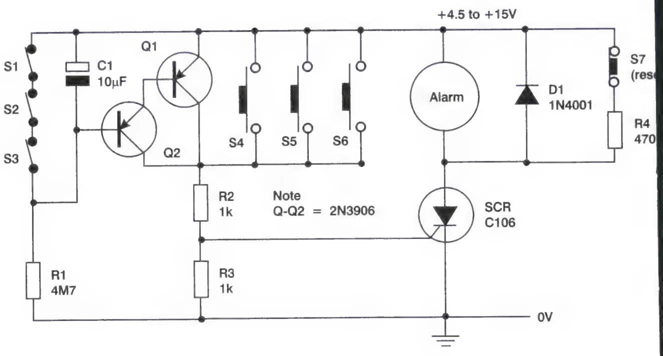


Figure 9. Improved burglar alarm circuit.

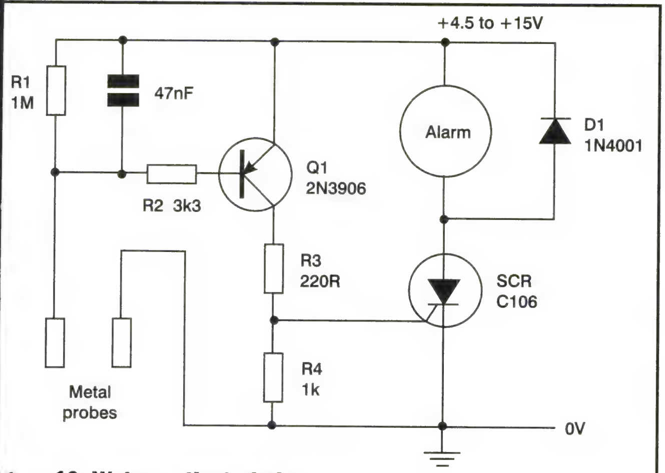
the AC side of the bridge, as in Figure 4.

Note that SCRs can also be used, in various ways, to apply variable AC power to various types of load, but that these tasks are usually best carried out by TRIACs, as will be described in a future article. However, two special types of SCR variable AC power control circuits are shown at the end of the present article.

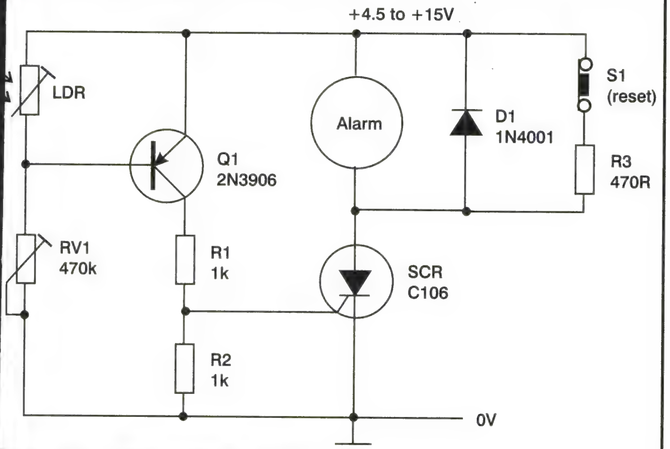
Bell/Buzzer Alarm Circuits

One useful application of the SCR is in DC-powered 'alarm' circuits that use self-interrupting loads such as bells or buzzers. These loads comprise a solenoid and a series switch, and give an action in which the solenoid first shoots forward via the closed switch, and in doing so forces the switch to open, thus making the solenoid fall back and re-close the switch, thus restarting the action, and so on. Figure 5 shows such an alarm circuit; it effectively gives a non-latching load-driving action, since the SCR unlatches automatically each time the load self-interrupts. The circuit can be made fully self-latching, if desired, by shunting the load with resistor R3, as shown, so that the SCR anode current does not fall below the SCR's minimum holding value as the load self-interrupts.

Figures 6 to 14 show a selection of alarm circuits of this type. All of these are designed around the inexpensive type C106 SCR, which can handle mean load currents up to 2.5 amps, need a gate current of less than 200μA, and has a 'minimum holding current' value of less



igure 10. Water-activated alarm.



igure 11. Light-activated alarm.

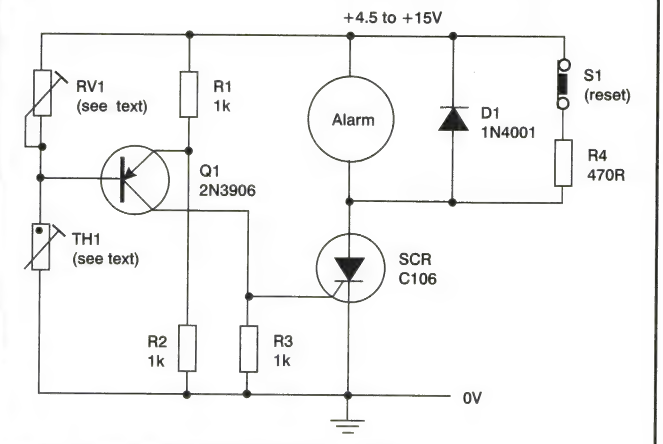


Figure 12. Simple over-temperature alarm.

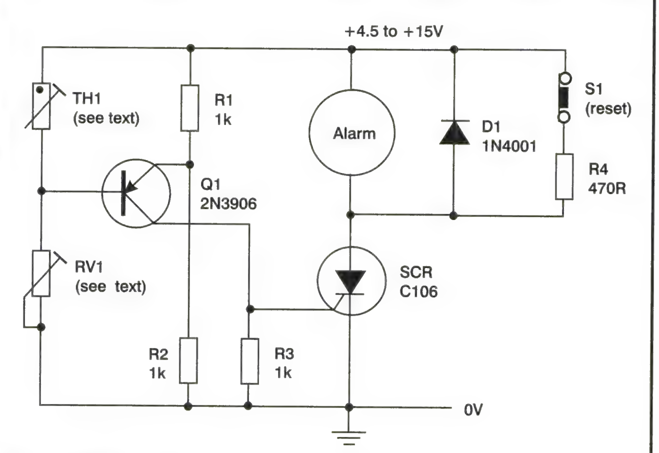


Figure 13. Simple frost or under-temperature alarm.

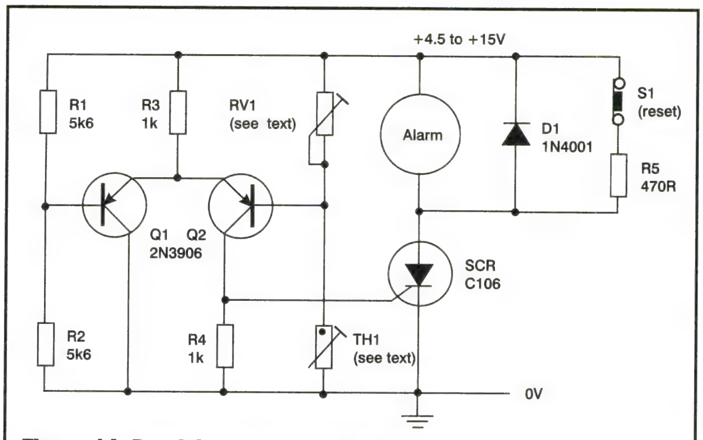


Figure 14. Precision over-temperature alarm.

than 3mA. Note in all cases that the supply voltage should be about 1.5V greater than the normal operating voltage of the alarm device used, to compensate for voltage losses across the SCR, and that diode D1 is used to damp the alarm's back-emfs.

Figure 6 shows a simple non-latching multi-input alarm, in which the alarm activates when any of the S1 to S3 push-button input switches are closed, but stops operating as soon as the switch is released.

Figure 7 shows the above circuit converted into a self-latching multi-input 'panic' alarm by wiring R3 plus normally-closed reset switch S4 in parallel with the alarm device. Once this circuit has latched, it can be unlatched again (reset) by briefly opening S4.

Figure 8 shows a simple burglar alarm system, complete with the 'panic' facility. The alarm can be activated by briefly opening any of the S1 to S3 'burglar alarm' switches (which can be reed-relays or microswitches that are activated by the action of opening doors or windows, etc.), or by briefly closing any of the 'panic' switches. C1 acts as a noise-suppressor that ensures that the alarm only activates if the S1 to S3 switches are held open for more than a millisecond or so, thus enhancing the circuit's reliability. The circuit consumes a typical standby current of 0.5mA (via R1) from a 6V supply.

The standby current of the burglar alarm circuit can be reduced to a mere 1.4μA (at 6V) by modifying it as shown in Figure 9. Q1 and Q2 are connected as a Darlington common emitter amplifier that inverts and boosts the R1-derived 'burglar' signal and then passes it on to the gate of the SCR. Here, C1 is used as a time-delay component that ensures that the alarm only activates if the S1 to S3 switches are held open for more than a few seconds; the C1 value can be greatly reduced, if desired.

Water, Light & Heat Alarms

The basic SCR-driven alarm circuit can be used to indicate the presence of excess water, light, or temperature levels by driving the SCR gate via suitable sensing circuitry; Figures 10 to 14 show alarm circuits of this type.

The Figure 10 'water-activated' alarm uses Q1 to activate the SCR when a resistance of less than about 220k appears across the two metal probes. It's operation as a water-activated alarm relies on the fact that the impurities in normal water (and many other liquids and vapours) make it act as a conductive medium with a moderately low electrical resistance, which thus causes the alarm to activate when water comes into contact with both probes simultaneously. C1 suppresses unwanted ac signal pick-up, and R2 limits Q1's base current to a safe value. By suitably adjusting the placing of the two metal probes, this circuit can be used to sound an alarm when water rises above a pre-set level in a bath, tank, or cistern, etc.

Figure 11 is a 'light-activated' circuit that can be used to sound an alarm when light enters a normally-dark area such as a drawer or wall safe, etc. The LDR and RV1 form a light-sensitive potential divider that has its output buffered via Q1 and fed to the SCR gate via R1. This output is low under dark conditions (LDR resistance is high), but goes high under bright conditions (LDR resistance is low) and thus drives the SCR and alarm on; the light-triggering point can be pre-set via RV1. Almost any small cadmium sulphide photocell can be used in the LDR position.

Temperature-activated alarms can be used to indicate either fire or overheat conditions, or frost or underheat conditions. Figures 12 to 14 show three such circuits. In each of these TH1 can be any n.t.c thermistor that has a resistance in the range 1k to 20k at the required trigger temperature; pre-set pot RV1 needs a maximum resistance value roughly double that of TH1 under this trigger condition.

The Figure 12 over-temperature alarm uses R1-R2 and TH1-RV1 as a Wheatstone bridge in which R1-R2 generates a fixed half-supply 'reference' voltage and TH1-RV1 generates a temperature-sensitive 'variable voltage, and Q1 is used as a bridge balance detector and SCR gate driver. RV1 is adjusted so that the 'reference' and 'variable' voltages are equal at a temperature just below the required trigger value, and under this condition Q1 base and emitter are at equal voltages so Q1 and the SCR are thus cut off. When the TH1 temperature goes above this 'balance' value the TH1-RV1 voltage falls below the 'reference' value, so Q1 becomes forward biased and drives the SCR on, thus sounding the alarm. The precise trigger point can be pre-set via RV1. The circuit's action can be reversed, so that the alarm turns on when the temperature falls below a pre-set level, by simply transposing the TH1 and RV1 positions as shown in the frost or under-temperature alarm circuit of Figure 13.

Note in these two circuits that if TH1 and Q1 are not mounted in the same environment, the precise trigger points are subject to slight variation with changes in Q1 temperature, due to the temperature dependence of its base-emitter junction characteristics. These circuits are thus not suitable for use in precision applications, unless Q1 and TH1 operate at equal temperatures. This snag can be overcome by using a two-transistor differential detector in place of Q1, as shown in the Figure 14 over-temperature alarm, which can be made to act as a precision under-temperature alarm by simply transposing RV1 and TH1.

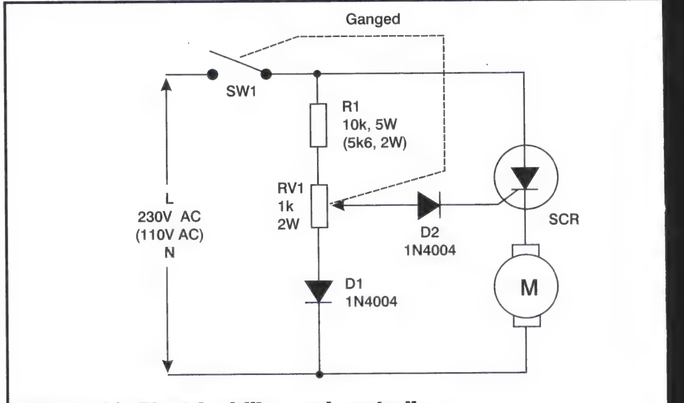


Figure 16. Electric drill speed-controller.

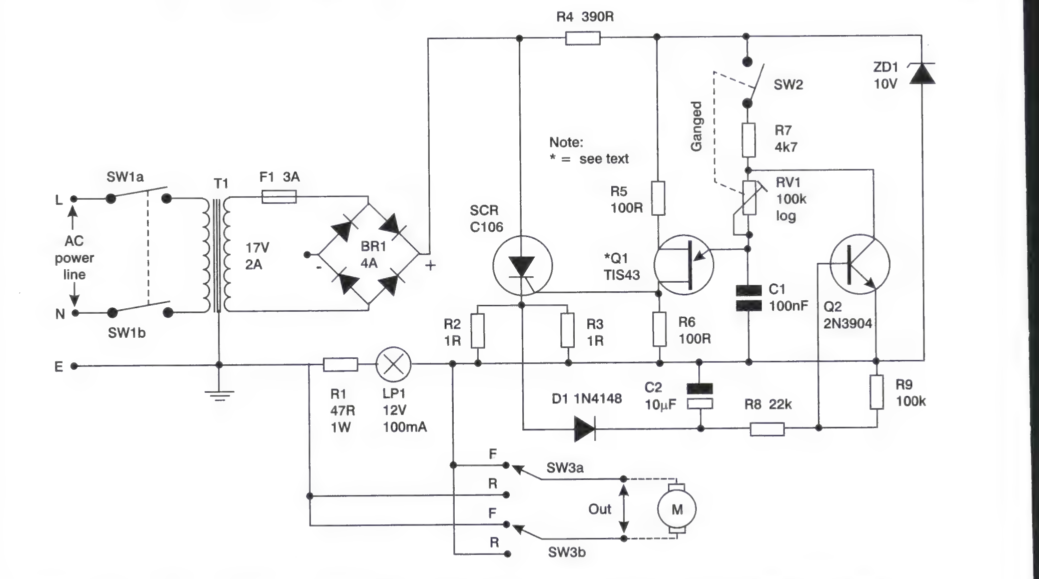


Figure 17. Model train speed-controller circuit with automatic short-circuit protection.

Variable AC Power Control

All SCR circuits shown so far give an on/off form of power control. SCRs (and TRIACs) can be used to give variable powe control in AC circuits in sever ways. One of these is via the 'phase-delayed switching' technique of Figure 15, in which power is fed to the loa via a self-latching solid-state power switch that can be triggered (via a variable phase delay network and a trigger pulse generator) at any point each power half-cycle, and automatically unlatches again the end of each half-cycle. Th diagram shows the load voltag waveforms that can be generated.

Thus, if the power switch is triggered near the start of eac half-cycle (with near 0° phase delay) the mean load voltage equals almost the full supply value, and the load consumes near-maximum power. If it is triggered near the end of each half-cycle (with near-180° phas delay) the mean load voltage i near-zero, and the load consumes minimal power. By varying the trigger signal's phase-delay between these extremes, the load's power fee

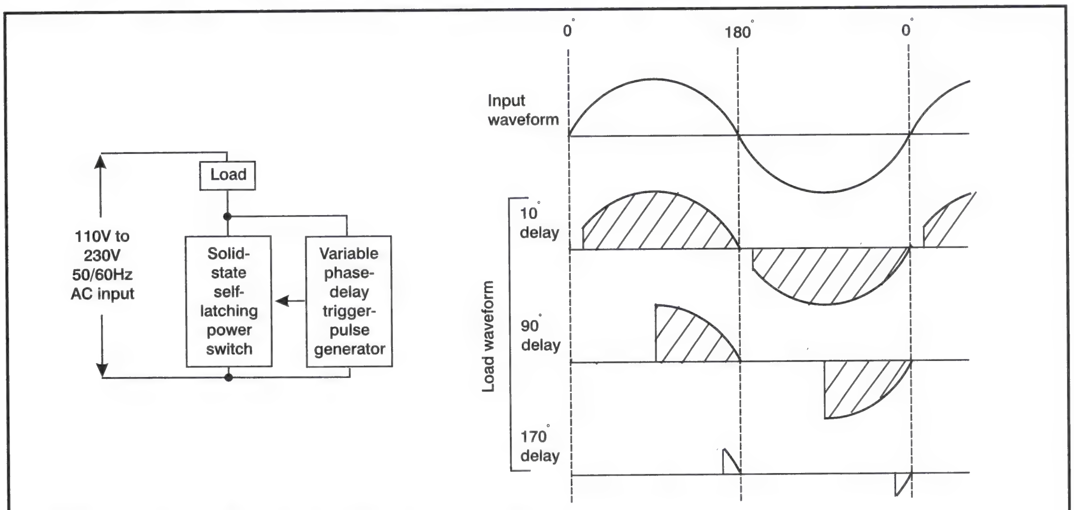

0°
180°
0°
Input waveform
Load
110V to 230V 50/60Hz AC input
Solid-state self-latching power switch
Variable phase-delay trigger-pulse generator
Load waveform
10° delay
90° delay
170° delay

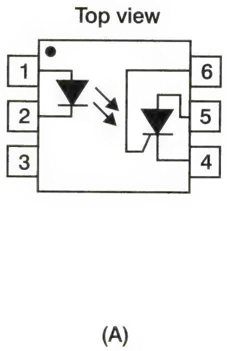
Figure 15. Variable phase-delay-switching AC power controller, with waveforms.

be varied between zero and ximum. This form of variable ver control is very efficient pically 95%), and can ongst other things) be used ontrol the speeds of many es of electric motor, uding those of electric drills model trains (see Figures nd 17).

Drill-Speed ontroller

st electric drills are powered series-wound 'universal' /DC) electric motors. These tors generate a back-emf t is proportional to the tor speed, and the motor's ctive applied voltage thus als the true applied voltage nus the back-emf. This gives motor a degree of speed -regulation, since any rease in motor loading tends reduce the speed and back-f, thereby increasing the ctive applied voltage and ising the motor speed to rise vards its original value, and on.

The speed of an electric drill n be varied electronically by ng the 'phase-delayed itching' technique. Figure 16 ows a particularly effective yet nple variable speed-regulator cuit. This uses an SCR as the ntrol element and feeds half-ve power to the motor (this uses a 20% reduction in ximum available eed/power). However, in the half-cycles the back-emf of e motor is sensed by the SCR d used to give automatic justment of the next gating lse, to give automatic speed gulation. The R1-RV1-D1 twork provides only 90° of ase adjustment, so all motor lses have minimum durations 90° and provide very high rque. At low speeds the rcuit goes into a high-torque kip cycling' mode, in which wer pulses are provided ermittently, to suit motor ading conditions.



Parameter	Optocoupled SCR
LED characteristic	
I_F (max)	60mA
SCR characteristics	
V_{MAX}	400V
I_{MAX}	300mA
I_{SURGE} (see text)	5A
Coupling characteristics	
isolating voltage	±1.5kV
input trigger current	5mA typical (20mA max)

(B)

Figure 18. Typical outline (a) and characteristics (b) of an optocoupled SCR.

Model-Train Speed Controller

Figure 17 shows how the 'phase-delayed switching' technique can be used to make an excellent 12V model-train speed-controller that enables speed to be varied smoothly from zero to maximum. The maximum available output current is 1.5A, but the unit incorporates short-circuit sensing and protection circuitry that automatically limits the output current to a mean value of only 100mA if a short occurs on the track. The circuit operates as follows.

The circuit's power line voltage is stepped down via T1 and full-wave (bridge) rectified via BR1, to produce a raw (unsmoothed) DC supply that is fed to the model train (via the track rails) via the series-connected SCR and direction control switch SW3. At the start of each raw DC half-cycle the SCR is off, so DC voltage is applied (via R4 and ZD1) to unijunction transistor (UJT) Q1 and its associated C1-RV1 (etc.) timing circuitry. C1 starts to charge up until eventually the UJT fires and triggers the SCR. As the SCR turns on it saturates, removing power from Q1 (which thus resets) and feeding the rest of the power half-cycle to the model train via R2//R3 (= R2 and R3 in parallel) and SW3. This timing/switching process repeats in each raw DC half-cycle (i.e., at twice the power line frequency), giving a classic phase-triggered power control action that enables the train speed to be varied over a wide range via RV1.

Note that the circuit's output current passes through R2//R3, which generate a proportional output voltage that is peak-detected and stored via D1-C2 and fed to Q2 base via R8-R9. The overall action is such that, because of the voltage storing action of C2, Q2 turns on and disables the UJT's timing network (thus preventing the SCR from firing) for several half-cycles if the peak output current exceeds 1.5A. Thus, if a short occurs across the track the half-cycle output current is limited to a peak value of a few amps by the circuit's internal resistance. The protection circuitry ensures that the SCR fires only once in (say) every fifteen half-cycles, thus limiting the mean output current to a mere 100mA or so. Note that the UJT shown here is an obsolete TIS43 type, but in practice any TIS43 or 2N2646 near-equivalent UJT can be used in its place.

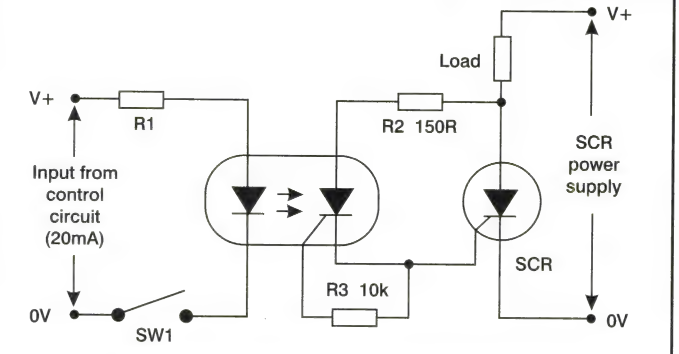


Figure 19. High-power control via an optocoupled SCR slave.

Optocoupled SCRs

SCRs are semiconductor power switching devices that (like transistors) are inherently photosensitive. An optocoupled SCR is simply an SCR and a LED mounted in a single package and configured so that the SCR's gate current is controlled by the LED's optical output. This enables the SCR to be controlled by a remote input current that is electrically fully isolated from the SCR's output (load) circuitry. Figure 18(a) shows the typical outline of an optocoupled SCR that is mounted in a 6-pin DIL package. Figure 18(b) lists the typical parameter values if such a device, which has a mean output load current rating of only 300mA but has a surge current rating of 5A at a pulse width of 100μS and a duty cycle of 1%.

Optocoupled SCRs are very easy to use. The input LED is driven in the way of a normal LED, and the SCR is used like a normal low-power SCR. The most important application of the optocoupled SCR is a 'slave' device that controls the gate current of a high-power SCR, which can activate a load of any desired power rating; Figure 19 shows an example of this type of application.

Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

September 2000

3 to 5 Sept. European Computer Trade Show (ECTS), Olympia, London. Tel: (0208) 742 2828.

10 to 13 Sept. PLASA - Light & Sound Trade Show, Earls Court, London. Tel: (0207) 244 6433.

13 to 14 Sept. OnBoard - Electronics Assembly Exhibition, Olympia, London. Tel: (01799) 528 292.

13 to 14 Sept. ECIF - Electronic Components Industries Fair, Olympia, London. Tel: (01799) 528 292.

17 Sept. National Vintage Communications Fair, NEC, Birmingham. Tel: (01392) 411 565.

19 to 20 Sept. Call Centre Expo, NEC, Birmingham, Miller Freeman. Tel: (0208) 742 2828.

21 to 24 Sept. Live - Consumer Electronics Show, Earls Court, London. Tel: (0208) 742 2828.

22 to 23 Sept. Leicester Amateur Radio Show, Donington Exhibition Centre, Derby. Tel: (01455) 823 344.

26 to 27 Sept. Business Systems Show G-MEX Centre, Manchester. Tel: (07000) 464 336.

26 to 28 Sept. GIS - Geographic Information Systems Exhibition, Earls Court, London. Tel: (0208) 742 2828.

27 to 28 Sept. Communications for Business, Barbican Centre, London. Tel: 01923 676 867.

October 2000

3 to 5 Oct. Coil Winding 2000, NEC, Birmingham. Tel: (0207) 417 7400.

4 to 5 Oct. Softworld Accounting & Finance, NEC, Birmingham. Tel: (0208) 541 5040.

9 to 11 Oct. TMA33 - Telecommunications Managers Association Exhibition, Stakis, Metropole, Brighton. Tel: (01372) 361 000.

11 to 12 Oct. SIT - Small Business IT Show, Bournemouth International Centre. Tel: (01934) 420 365.

11 to 12 Oct. TEST - Electronic Testing Exhibition, NEC, Birmingham. Tel: (02476) 230 333.

11 to 12 Oct. Webmaster - Web & Internet Show Olympia, London. Tel: (01256) 384 000.

11 to 12 Oct. JAVA - Computer Software Trade Exhibition & Conference, Olympia, London. Tel: (01256) 384 000.

17 to 18 Oct. Property Computer Show, Barbican Centre, London. 01273 836 800.

18 to 19 Oct. PHOTONEX/FIBRE EXHIBITION, NAC, Stoneleigh, Coventry. 01932 866 766.

25 to 26 Oct. Accounting IT, Business Design Centre, London. Tel: (0207) 221 1155.

24 to 25 Oct. OSPMA FieldComms - Industrial Networking Show, Telford International Centre. Tel: (0207) 417 7400.

31 Oct to 2 Nov. Voice Europe Olympia, London. Tel: (01244) 378 888.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?

Effects of Low Level Electromagnetic Fields Not Proven Says IEE

There is still no convincing scientific evidence showing harmful effects of low level electromagnetic fields on people, according to a statement from the IEE (Institution of Electrical Engineers).

The IEE's assessment is the result of examining over 700 relevant refereed papers published throughout 1998 and 1999, covering five areas: cellular, animal, epidemiological and human studies and mechanisms of interaction.

At low frequencies, recent evidence from major epidemiological studies and the cumulative evidence from the large body of literature built up over the past 20 years suggests that the existence of harmful effects is unlikely.

The IEE believes, therefore, that future proposals for low frequency electromagnetic field research should now be weighed carefully against other public-health priorities.

At higher (radio) frequencies less data is available. Whilst existing data does not show harmful effects, the Working Party believes that further research, both epidemiological and laboratory based, is needed.

This view is based on public concern and the increasingly ubiquitous nature of our exposure t such fields rather than a likelihood that harmful effects exist.

The statement is the fifth produced by a specialist independent Working Party set up by t IEE in 1992 to consider the possible harmful effects of low level low frequency electromagnet fields. In January 1998 the Working Party's terms reference were extended to include frequencies to 300GHz to reflect public concern over possibl health effects of radio frequency energy - from mobile communications systems in particular. For further details, check: **`<www.iee.org.uk>`**. Contact: IEE, Tel: (020) 7240 1871.

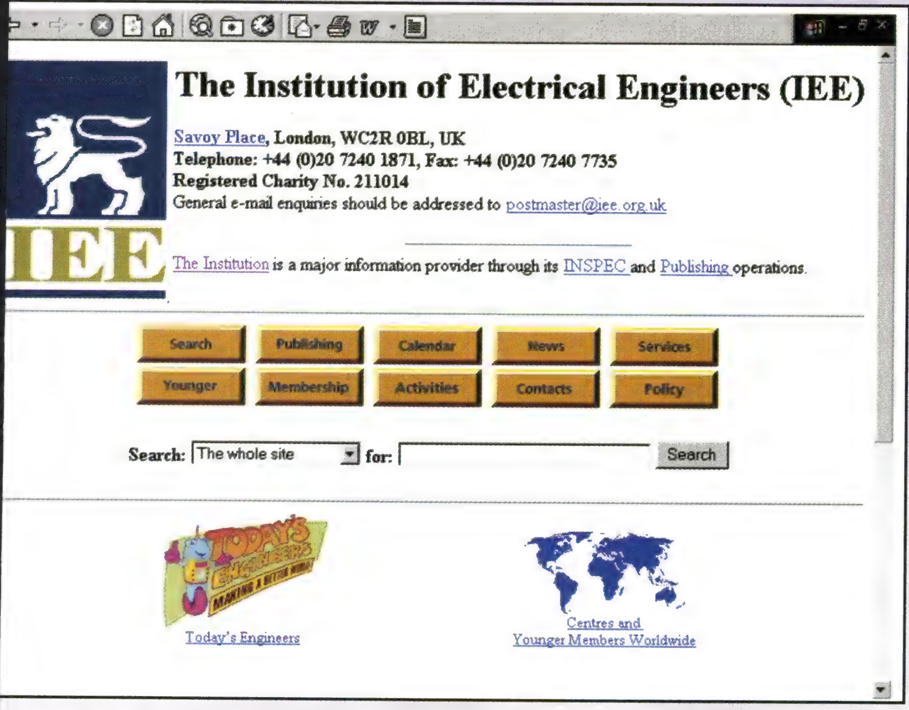
Single Message on Professional Development as Engineering Bodies Combine

Three of the UK's engineering organisations hav pledged to work together to support the professional development of their members.

The agreement was ratified in June by the signing of a Memorandum of Understanding by t Presidents and Chief Executives of the IMechE (Institution of Mechanical Engineers, the IIE (Institution of Incorporated Engineers) and the IEE (Institution of Electrical Engineers).

The Institutions have agreed a common policy and have already issued guidance to all their members on the best way to undertake a structure programme of development based on assessmen of competence.

Together the three organisations represent ove 260,000 chartered, incorporated and technician engineers in the fields of electrical, electronic, mechanical and manufacturing engineering. For further details, check: **`<www.iee.org.uk>`**. Contact: IEE, Tel: (020) 7240 1871.



The Institution of Electrical Engineers (IEE)

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Registered Charity No. 211014
General e-mail enquiries should be addressed to postmaster@iee.org.uk

The Institution is a major information provider through its INSPEC and Publishing operations.

owells Welcomes Plans r Strong New Energy nsumer Council

posals to create a strong consumer body gas and electricity consumers nounced today were welcomed by nsumer Affairs Minister, Dr Kim Howells.

The new proposals for the Gas and ctricity Consumer Council, being set up der the Utilities Bill, were put forward by n Robinson, Chair of the Gas Consumer uncil and Chair-designate of the new uncil following an extensive consultation ercise.

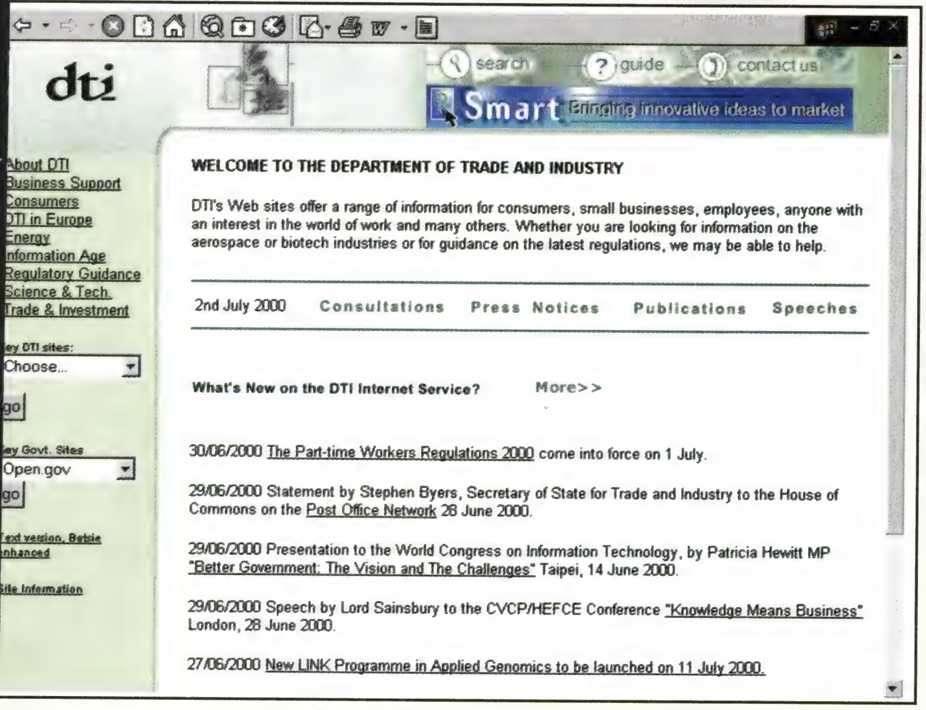
The new Gas and Electricity Consumer uncil (GECC) being set up under the Utilities Bill will merge the existing Gas Consumers' Council and the 14 Regional Electricity Consumers' Committees. This reflects trends where the same company now increasingly supplies both gas and electricity and there have been many new entrants to the market place.

- Suppliers' selling practices
- Processes for transferring customers
- Billing problems Accurate meter readings
- Gas safety
- Problems of the fuel poor

Remit of Gas and Electricity Consumer Council (GECC)

For further details, check: **<www.dti.org.uk>**.

Contact: DTI, Tel: (020) 7215 5000.



WELCOME TO THE DEPARTMENT OF TRADE AND INDUSTRY

DTI's Web sites offer a range of information for consumers, small businesses, employees, anyone with an interest in the world of work and many others. Whether you are looking for information on the aerospace or biotech industries or for guidance on the latest regulations, we may be able to help.

2nd July 2000

What's New on the DTI Internet Service?

30/06/2000 The Part-time Workers Regulations 2000 come into force on 1 July.

29/06/2000 Statement by Stephen Byers, Secretary of State for Trade and Industry to the House of Commons on the Post Office Network 28 June 2000.

29/06/2000 Presentation to the World Congress on Information Technology, by Patricia Hewitt MP "Better Government: The Vision and The Challenges" Taipei, 14 June 2000.

29/06/2000 Speech by Lord Sainsbury to the CVCP/HEFCE Conference "Knowledge Means Business" London, 28 June 2000.

27/06/2000 New LINK Programme in Applied Genomics to be launched on 11 July 2000.

Science Enterprise Challenge

Stephen Byers, Secretary of State for Trade and Industry today announced that an additional four Science Enterprise Centres are to be established, these will complement the eight centres announced in September 1999.

The new centres will be Durham (in collaboration with the universities of Newcastle upon Tyne, Northumbria at Newcastle, Sunderland and Teesside), Warwick (in partnership with Birmingham), Ulster (with Queen's University of Belfast) and Oxford.

The centres, which are part of the Science Enterprise Challenge, aim to develop business expertise in science and transfer knowledge from the science lab to the marketplace.

For further details, check: **<www.dti.org.uk>**.

Contact: DTI, Tel: (020) 7215 5000.

Lord Sainsbury Launches Investment Programme In Optical Internet Technologies

A multi-million pound Government investment in the future of the UK's optical technology industry has been announced by Science Minister Lord Sainsbury.

The £11 million programme, aimed at encouraging greater links between universities and companies to develop new optical applications, will be matched by the private sector. Overall more than £20 million could be spent over the next five years, helping to keep the UK at the forefront of this high-tech sector.

Optical systems allow massive increases in computing and communications power, transmitting and processing information at the speed of light.

Potential participants should contact Dr Peter Batchelor (DTI) on 020 7215 1342 (e-mail: peter.batchelor@dti.gsi.gov.uk) or Glenys France (EPSRC) on 01793 444319 (e-mail: glenys.france@epsrc.ac.uk).

For further details, check:

<www.dti.org.uk>.

Contact: DTI, Tel: (020) 7215 5000.

Software HINTS & TIPS

by Mike Bedford

This month we argue that less is sometimes more as we turn our attention to designing documents using Word 97.

For the last few months, we've been looking at some of the lesser known facilities of Word 97. Generally, I have described how to use these features and suggested how you can delve further. This month, though, I am not going to look so much at what you can do as much as what you should do.

Fonts

It's not much of an exaggeration to say that word processors have now got to the point where just about everything is possible with their capabilities further extended by disks containing vast libraries of clip art and fonts. For many people the temptation to use these products to the full is overwhelming. It's as if some people think "if I've got 1,000 fonts, hundreds of megabytes of clip art and thousands of colours, then I'm going to use them all". I'd like to suggest, though, that you try to exercise some discretion in what you use. Documents which use dozens of fonts and colours on the one page often look dreadful. The 'ransom letter' style generally isn't the way to go. The following makes the point although it is, admittedly, something of a parody.

Less is often more - a tastefully designed document can by very eye-catching even if it only uses a couple of fonts and a handful of colours. Ironically, it requires more skill to use lots of fonts successfully yet it's often the amateur type setter who is tempted to go overboard. My suggestion, therefore, is to start out with just a couple of fonts, perhaps Times New Roman for the body text and Arial for the headings. And when you do decide to liven things up a bit, how about looking for fonts which are subtly different from these two basic ones rather than the more bizarre fonts. Take the trouble to scrutinise fonts to find ones you find pleasing. You'll probably find fonts which are sufficiently different from Times New Roman to be interesting but not so different as to be difficult to read. The more unusual fonts should be used very sparingly for special purposes and effects.

Don't use
the **RANSOM**
LETTER *look*

Subtle differences
Subtle differences

Before moving on from fonts, there are a couple of interesting types of characters you may not be familiar with. First of all let's think about capital letters. The rules of grammar dictate that we have to use them in certain places such as the start of a sentence and for abbreviations. However, using capital letters in abbreviations tends to draw undue attention to them so there's been a recent trend to use lower case letters. An interesting alternative which is grammatically correct yet doesn't cause them to 'shout' is to use small capitals. These can be selected in Word 97 under Format > Font.

Similarly, have you noticed how figures also tend to draw undue attention to themselves? The reason is that the figures we're used to are actually upper case (i.e. capital figures). However, there are also lower case figures and these, like the lower case letters, vary in their height and in whether or not they have descenders below the base line. As such they fit in well with lower case letters and don't stand out like the proverbial sore thumb. Unfortunately, there's no way you can select lower case figures like we selected small capitals. It all depends on the font - most have upper case figures but a few have lower case ones. None will have both, though, since the ASCII character set doesn't make provision for both. This is something you may like to consider when choosing fonts.

TLAs tend to stand out, but not with small capitals – TLA.

Figures – 1234567890 – tend to stand out. Lower case figures – 1234567890 – don't.

Creating Emphasis

Emphasised text is used both in titles and to draw particular attention to a word or phrase within the main body text. As you'll be aware, modern word processors provide lots of ways to emphasise text. A larger point size, a different colour, a different font, underlining, emboldening, italicisation and capitalisation are just some of the methods available and it's common to see all of these in use. However, there are some that I would advise against. Number one on my list of pet hates is underlining. This has never been a mainstream typographic convention, the only reason it came into use is that it was one of the few methods available on the typewriter and later on the dot matrix printer. Now we have inkjet and laser printers there are much better methods - the ones which have been used by professional publishers for centuries and which readers expect to see.

Emphasise by **emboldening** or *italicising*, not underlining.

Obviously personal preferences come in here but my suggestion would be to use emboldening, italicisation or both to emphasise body text and to use a larger font size, probably in a different font and emboldened for titles. A different colour could also be used here although do keep to something subtle.

Colour

Since we have now touched o colour let us consider its use i documents and, as with most things, don't go overboard wit it. With the exception of photographs which will, of course, be in every imaginable colour, devise a colour scheme using, perhaps, as little as two or three colours and keep to them. If possible, try to use a limited palette of colours in your line illustrations too. And as I suppose you've already guessed, my suggestion is to avoid loud colours. A document with blue body text and red titles will look incredibly tacky and will rapidl tire your readers - you've been warned!

Use of Colour
This is one good way to get on your readers' nerves.

Using a slightly different colour for the headings, and perhaps for illustrations can look quite attractive. You will notice, for example, how I have used brown text for the various examples in this article. Unfortunately, though, Word 9 isn't especially good with subtle colours. Only sixteen colours are provided and these tend to be either the bright colours or the dirty browns. This is, perhaps, one of the few areas where word processors still lag behind a proper DTP package.

Be Subtle
Using a subdued colour scheme can be effective. Unfortunately, though, Word 97 doesn't give you much choice.

Practice Makes Perfect

Really, design is a subject that can only be taught to a degree. My aim in this column, therefore, is just to raise awareness of the various issues and to suggest, as tactfully as possible, that your documents probably leave some room for improvement (I know mine do). And if you've come to that point it's over to you. The saying that practice makes perfect is as true here as anywhere. So try out different styles and get friends to look at your results with a critical eye. And although I wouldn't suggest plagiarism, do look at books and magazines with a more critical eye to try to get some tips from the professionals.

TECHNOLOGY WATCH

With Martin Pipe

This month, I'm going to comment on some of the latest developments in digital video, audio and broadcasting. f you're a regular reader, you'll know that hese are subjects close to my heart. udging by the number of e-mails I get rom 'Electronics' readers, it's clear that I'm ot the only one with such interests. There re disadvantages to the technologies - as vell as advantages. Take the case of Sky, for xample. Through its digital broadcasting ervice, this broadcaster is responsible for everal innovations, including interactive ews and sports coverage. It is currently rying to migrate its existing analogue ubscribers (myself included) to Sky Digital. One can hardly blame it - after all, the cost f those analogue transponders on Astra 1x un into tens of millions of pounds each ear, and it understandably wants to shut hem down at the earliest opportunity. It is urrently offering free Digiboxes to existing ubscribers, but on the proviso that they ay for them to be installed (basically, they wap your existing dish/LNB for the smaller Sky Digital one, and use the existing coax able run. This way you can't retain your nalogue set-up, and thus enjoy the other nalogue and digital channels available from 19°E!). As we near the analogue shutdown date (which, at the time of writing, has not been finalised), one can expect that Sky will probably offer incentives of ever-increasing generosity. I can imagine that the installation charge will be waived for a start. I doubt very much that Sky will want to lose subscribers paying upwards of £250 per year when those analogue screens finally do go blank! Sky has already sent around salesmen to try and convince me. No such luck - I'm going to hold on until the bitter end. By then, Sky will hopefully provide the Digibox of my choice. This will be the Sony, which is the only current model to feature a S/PDIF digital audio output. At the present, all free Digiboxes are standard Pace and Amstrad models.

The wonderful new world of digital broadcasting isn't without its drawbacks, though. Take a look at the wonderful Sky TV guide, which is sent to all broadcasters whether they like it or not. The magazine sent to analogue subscribers may be full of gushing puffery (I, for one, cannot recall any letter critical of Sky) but does offer channel listings. The version sent to digital subscribers doesn't have these listings, making it difficult for them to plan their viewing. But then again, Digiboxes don't have event timers, and so you can only time-shift from one channel. This will surely be great fun when analogue terrestrial transmissions are closed down! Just about every analogue receiver produced over the last five years, by the way, is equipped with one of these event timers, which switches channels at user-defined times. The digital TV guide, which is notably thinner than the analogue one, consists in the main of lightweight articles. There are only cursory previews of what you can expect to see over the coming month. If you want precise scheduling details, then you have to rely on the on-screen electronic programme guide (EPG) instead. This only works over a few days, rather than the entire month covered by the paper guide. Using the EPG - which is rather slow to appear, particularly if you're looking ahead - may well interrupt the viewing of another family member, and will certainly ruin any recordings being made. Not that you should be making recordings, dear me no... Sky Digital, then, isn't the best choice for those who travel periodically - you'll simply have to wait until the programme you wanted to watch is retransmitted. If, of course, it is - and you can find out when...

One of Sky Digital's great advantages is that teletext information carried as part of the DVB datastream which is re-inserted into the TV picture's vertical blanking interval (VBI). It can thus be decoded by any analogue teletext TV. The situation with ONdigital is rather different. Here, the teletext is - or will be, when it finally gets off the ground - transmitted on a separate channel. Utterly ridiculous, because it means you have to interrupt your viewing (or recording) when you want to check up on some information via teletext. As a form of compensation, the terrestrial digital teletext services will offer pretty graphics, still images and other gimmicks - but I know what I would prefer! ONdigital currently has little spectrum, certainly compared to what Sky has available. Although teletext data occupies little bandwidth relative to a MPEG-2 video/audio signal, it soon adds up across the range of channels offered. With UHF spectrum being as scarce as it is, ONdigital has probably decided to invest the bandwidth involved on additional TV channels. I can imagine that when terrestrial TV is shut down, some of the frequencies thus released will be made available to ONdigital. They may choose to piggyback the teletext information associated with a particular channel in the traditional manner, as Sky does. The chipsets employed within the ONdigital set top boxes will probably support the decoding of teletext packets and VBI-insertion, and the relevant firmware upgrade could be issued to receivers 'over the air'. That's not to say that Sky Digital has it all its own way. Channel 4's teletext is a pale imitation of its analogue terrestrial relative, while Sky One's simply tells you to use the EPG. Why not simply retransmit the services that accompany the analogue channels?

Another problem with both digital services - that of recording and watching different channels simultaneously - will, no doubt, be solved by the time the great analogue shutdown occurs. By then, cheap terrestrial set-top box add-ons should be available, or so the government tells us! These boxes will probably only decode the free-to-air channels. If you want to receive two different pay-TV channels simultaneously, then you'll need two decoders - and two subscriptions! We're used to that with analogue satellite, though. Less easy to address, however, is the issue of picture quality. The Euro2000 football tournament provided me with a welcome opportunity to compare digital with analogue, courtesy of BBC1's coverage. And guess what - analogue came out considerably better, with fewer unpleasant artifacts and greater clarity (note that our free-to-air Digibox was connected to the TV via a direct RGB Scart link). This difference in picture quality is quite worrying, seeing that most of us will need a Digibox (and a heavy subscription) if continued enjoyment of football is envisaged. But then again, there was no ghosting. If you live in an area notorious for its poor terrestrial coverage, the Digibox will give you pictures of a quality that was previously denied to you. As long as they have clear view of the satellite, viewers across the whole country should experience identical results. In terms of sound quality, though, there was little difference. If anything, digital should be better on account of the 48kHz sampling rate, which compares favourably with the 32kHz employed by analogue TV's NICAM stereo system.

Indeed, sound is where the greatest benefit of digital satellite broadcasting is realised. The BBC, and several commercial operators, disseminate their services via the Astra 2A satellite. These stations, which include some unavailable anywhere else, can thus be received on any Sky Digibox. The key services (Radios 1 to 4, Virgin, Heart, Classic FM, etc.) are transmitted with MPEG-1 Layer-2 encoding at 192Kbps, and a sampling rate of 48kHz. Even with an unmodified Sky Digibox feeding analogue stereo signals to a hi-fi system via its phono outputs, the sound quality is nothing short of revelatory even when compared to the best analogue FM tuners (I've undertaken side-by-side listening tests with a Revox model). As we discovered in the February 2000 issue of 'Electronics', the Digibox's analogue outputs can be modified for improved sound quality. Unfortunately, there's no S/PDIF output. Sky's Digibox, the design of which appears to be largely standardised by the broadcaster, employs an AKM 4319 DAC.

Followers of my series of articles on the MP3 audio system may well recall my description of how an S/PDIF output could be added to the Creative Labs Soundblaster 16 (SB16) soundcard, courtesy of the Cirrus CS8402A IC. Further details can be found in the July and August issues of 'Electronics'. The SB16 is - ironically enough - also based around an AKM chip. Could you carry out a similar modification to the Digibox? For a start, you would need a very steady hand because the surface-mounted 4319 has a very fine pin pitch. Some other work is required - the circuit described is optimised for sample rates of 44.1kHz, rather than 48kHz. Some changes to the circuit are thus required. The frequency of the external clock fed into the CS8402A must be directly proportional to the required sampling rate. Clever divider chains may be necessary, if you can't find suitable clock around the receiver's digital audio circuitry. Some of the option-setting pins described in the original circuit may also be different. The datasheet for the CS8402A can be downloaded from `http://www.cirrus.com/ftp/pubs/`.

It's a Nok-out!

You don't need a Digibox to receive these radio services, which provide a cost-effective and more flexible alternative to DAB. Most are unencrypted, and can be decoded by a 'free-to-air' DVB satellite receiver - which will also pick up many TV channels into the bargain! In the February issue, we described how a S/PDIF output could be added to Nokia's 9200 receiver - similar comments also apply to the company's 9500 and 9600 models, encryption-ready receivers that employ the same basic MPEG hardware. You might be able to modify other DVB receivers along similar lines. The mod works very well, and I have fed the output to Minidisc decks and external DACs without trouble. For some strange reason, I have had very limited success getting it to work with a Sony DTC790 DAT recorder - it doesn't, for some reason, seem to like the 48kHz signals. I have found that the link does work well with the 44.1kHz-sampled free-to-air Music Choice channels. There are three of these, by the way, all of which play continuous music back-to-back without interruptions or DJs. Note that DAB multiplexes offer no such channels! They're broadcast on 12.188MHz, with horizontal polarisation, a symbol rate of 27500 megasymbols per second and a forward error correction (FEC) of 2/3.

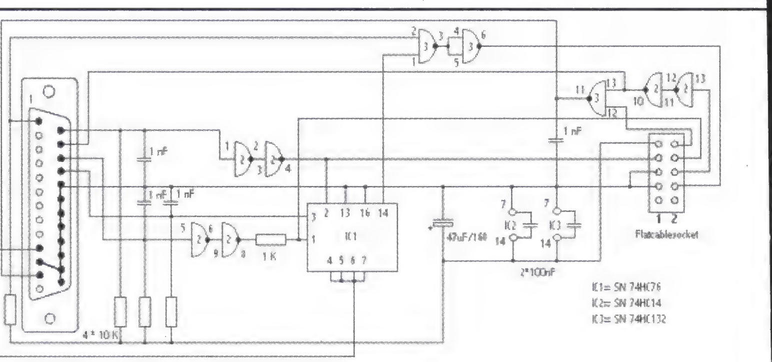


Figure 1.

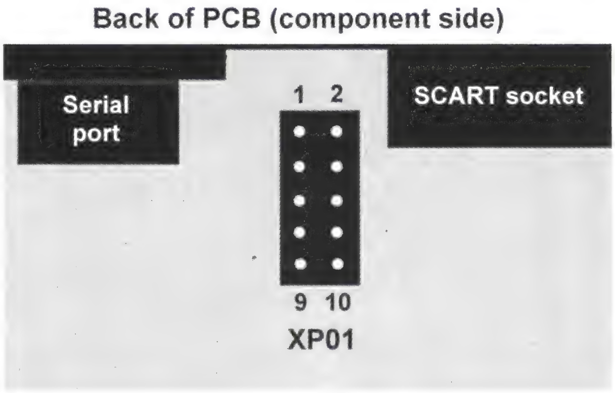
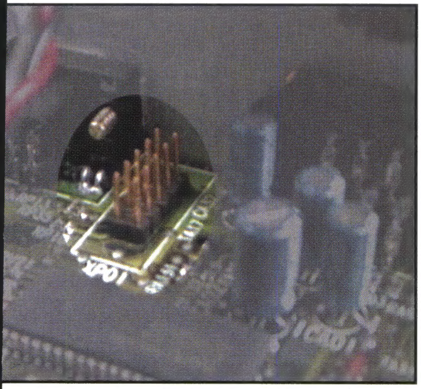


Figure 2.

If you conduct a search with these settings, you'll find several tens of channels, with names like 'Jazz', 'Classic Rock' and 'Opera'. The vast majority of these themed music channels are encrypted with Videoguard, and are pay-radio services available at additional cost to Sky Digital subscribers (if you're interested, check out `http://www.musicchoice.co.uk` for more details). The search will, however, also reveal the trio of free services. They're easy to spot in the list, thanks to their rather odd identification tags. The services, which are found as '1946', '1947' and '1948', are actually called 'Synergy', 'Fidelity' and 'Style' respectively. Between them a wide range of music, from classical to pop, is available. Although free, they're intended only for Sky's subscribers. Odd then that they're unencrypted, but one mustn't complain! Other interesting free-to-air radio services include Core, CNN Radio, Planet Rock and Premier Christian Radio. You'll also be abl to receive channels carried on satellites co located with Sky Digital's Astra 2A at its orbital position of 28.2°E. One such satelli is Kopernicus F2 - as a result, you can also enjoy listening to radio from the Czech Republic and the Netherlands. More will undoubtedly follow, expanding still furthe the listening choice!

There is, however, even more - if you have a Nokia receiver, that is! Direct-to-dis recording, free MP3 downloads, and even the display of digitised PC images on your TV set are all possible! Nokia's receivers have proved popular - versions equipped with conditional access hardware are issue to the customers of many European pay-T operators. Their excellent availability and flexible hardware specifications have appealed to the die-hard enthusiast, some of whom have rewritten the Nokia operati system firmware to provide new features. Nokia has made this easy - the software resides in flash memory, rather than EPRO - so that purchasers of its hardware can keep abreast of DVB developments. Indee the 'official' Nokia upgrades can be found on its web site. The original free-to-air operating system didn't cater for single-channel-per-carrier (SCPC) services or the manual entry of audio/video packet identifiers (a necessary feature for obscure channels and feeds). The upgrades provide such features, and others to boot. The sam Web page **`(http://www.nokia.com/multimedia/downloads/index.html)`** also contains links to a PC program that allows you to transfer the new firmware (which is supplied in the form of a .bin file) to your receiver via its serial port. Unfortunately, the process is rather slow - and indeed not particularly

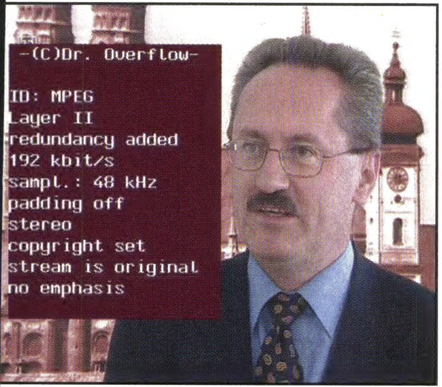
Sony has announced a TiVo-compatible set-top box. And this is what it looks like...



ation of XP01 and XP06

able (particularly if you're using an lier bootloader, more of which shortly). ankfully, Nokia has provided an ernative - although it requires access to receiver's innards. Towards the back of receiver's PCB is a 10-pin header minal (marked as 'XP01'), which ginally intended for factory programming d development. It's possible to interface s connector, using the simple 'BDM, or ckground debug module' circuitry tailed in Figures 1 and 2, to a PC's parallel rt.

Programming is now considerably faster, hough you'll need different PC software the task. I use TranxBDM, which can be wnloaded from a variety of sites including **tp://www.dominance.net/overflow**. The ftware is easy to use - pressing a single tton ('program') invokes a sequential ocess in which the existing firmware is leted from the memory, and the new mware loaded, in 'blocks'. You're advised back-up the original firmware first, using e 'read' button. The BDM and TranxBDM ay also be required to update the otloader - a separate item of firmware at initialises the receiver on start-up, and ads the software into the receiver's RAM. e version of the bootloader currently stalled is shown, albeit extremely briefly, the display at switch-on. Early versions of e bootloader (1.01, for example) result in oblems when trying to install new erating system firmware. Replacement otloaders - a good choice is Nokia's 2.00Uns - can be downloaded from several fferent websites, including **tp://www.satinf.com/nokia/osnokia.htm.** replace the bootloader, you will need to ridge the protection jumper XP06. You can se a standard 0.1in. jumper of the type ften used to set configure PCs - but don't rget to remove it after programming! An dvantage of the updated bootloader is that permits replacement operating systems to be transferred to the PC across the serial port with greater reliability. The transfer speed is still slow compared to what's possible with the BDM, but then again there's no need to get inside the receiver.

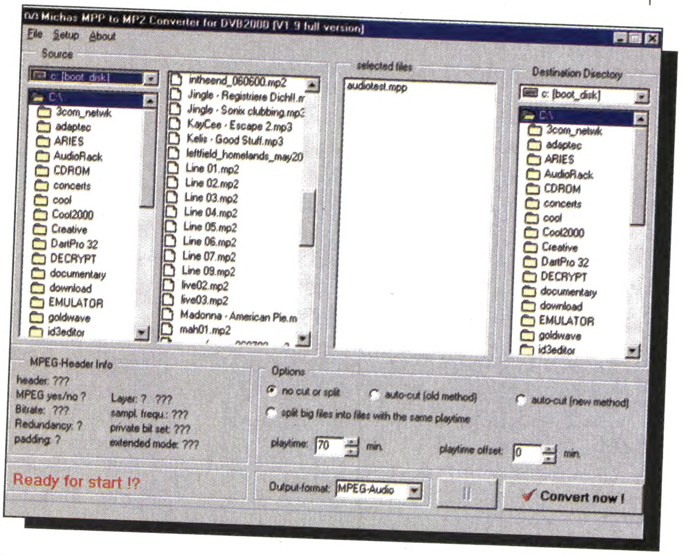


```
-(C)Dr. Overflow-

ID: MPEG
Layer II
redundancy added
192 kbit/s
sampl.: 48 kHz
padding off
stereo
copyright set
stream is original
no emphasis
```

Replace the operating system with a newer Nokia version adds some nifty features that aren't obvious - enable the S/PDIF output pin of the CS4920 MPEG audio processor (refer to the February 2000 issue of 'Electronics), there are alternatives. Some of the others currently in circulation are capable of more features (albeit at the expense of user-friendliness). The aforementioned satinf.com site provides links to a fair number of these third-party operating systems. One of the best is Dr. Overflow's shareware DVB2000 **(http://www.dvb2000.org)**. It makes full use of the hardware, bringing out much of the functionality offered by the core chipset. You're presented with all kinds of parameters that can be adjusted through a battery of on-screen menus. DVB2000 is also capable of providing a considerable amount of information about the received signal - if you want more, you'll probably have to spend thousands of pounds on a professional-grade DVB test set! Much of the added functionality can be attributed to a high-speed PC interface - which has been exploited by various programmers to provide additional functionality. All of this is possible because Nokia decided to endow its receivers with a Fast SCSI-2 interface; the original idea was that users could hook up a CD-ROM drive to the back of the unit, and play Video CDs. With DVB2000 installed on your Nokia receiver, and a SCSI card installed in your PC, the fun can really begin. It's a shame that SCSI ports, or interfaces of equivalent performance, seem to be disappearing from digital satellite receivers. Without them, nothing of what I'm about to describe would be possible.

Let's start with something that will appeal to die-hard scanners of the skies. DVBEdit, also available from the dvb2000.org site, features a band scanner. This is very useful since it allows you to spot new transponders and satellites. Its display resembles that of a spectrum analyser. Moving swiftly along, the Dr. Overflow team have written an excellent Windows 9x program - VGrabber - to fully exploit the link between PC and satellite receiver. Turn on the receiver, and then boot up your PC. Run VGrabber (available, once again, from dvb2000.org), and the receiver should be appear on the displayed list of SCSI devices. I had problems here until I told Windows to 'detect new hardware' - this presumably gets the ASPI drivers to recognise and talk to the receiver. You don't need a fancy SCSI card - the one in the test PC is a bargain-basement Adaptec 2904. The default SCSI ID given to the receiver is 3 - if this conflicts with other devices on your SCSI chain, you'll be pleased



audiotest.mpp

header: ???
MPEG yes/no ?
Bitrate: ???
Redundancy: ?
padding: ?
Layer: ? ???
sampl. frequ.: ???
private bit set: ???
extended mode: ???

● no cut or split
○ auto-cut (old method)
○ auto-cut (new method)
○ split big files into files with the same playtime
playtime: 70 min.
playtime offset: 0 min.

Ready for start !?

Output-format: MPEG-Audio

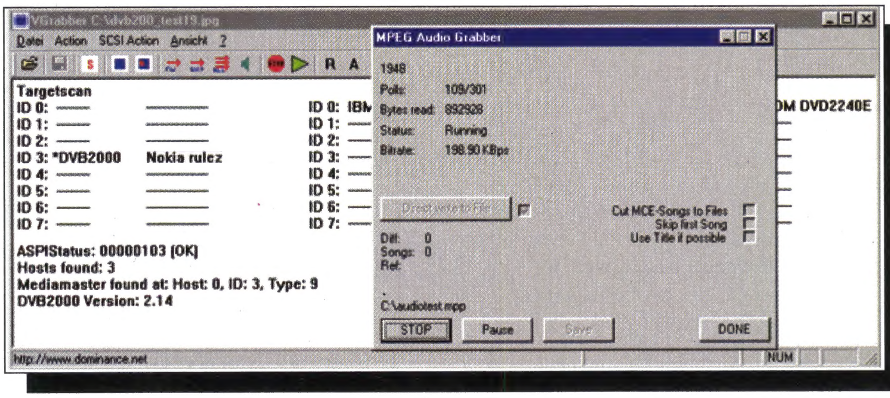
to know that it can be changed via one of the on-screen menus. Note that the receiver should be the last device on a SCSI chain, because it incorporates a terminator. Most of the program's real functionality is located in the 'SCSI Action' menu. From here, you can transfer new firmware to the receiver, transfer channel databases and grab TV pictures with or without on-screen graphics (great for 'long-distance' TV enthusiasts). You can also send pictures (BMP or JPEG) from your hard disk to the receiver - they're then displayed on your TV screen. I can imagine this feature being of great interest to video editing enthusiasts, because they can now commit title screens, digital photographs and scanned images onto tape with the highest possible image quality!

Of greatest interest to Electronics readers, however, is Vgrabber's 'streaming' feature. Here, MPEG audio and video streams can be saved directly to the PC's hard disk - pipping to the post those forthcoming Sky Digiboxes with in-built mass storage! You can also save other types of datastream (for example, teletext) by entering the packet identifier value - we'll discuss one valuable application of this shortly. At the time of writing, simultaneous capture of video and audio isn't possible. A future version of Vgrabber will, no doubt, rectify this. Capturing audio streams from radio stations is, for now, the greatest application of the software. In other words, you can make recordings with absolutely no quality loss relative to the original broadcast. Audio streams can be saved directly as mp2 files, which can be played by Winamp. Sometimes, however, there are audible 'glitches'. These are caused when some of the transport-related header information (synchronisation and so on) transmitted with the audio datastream isn't removed. A better option is to save audio streams in their 'raw' state (MPP file format) and a converter program that can be downloaded from the DVB2000 web site. This program (mpp2mp2v19a_full_registered.zip) will convert raw captures to MP2 files, stripping away any information that isn't audio-related. The 'Michas MPP to MP2 Converter' also features a track splitter, and the ability to convert those MPEG audio captures into WAV files. The latter will, of course, benefit those who want to make CDs from live concerts and other such broadcasts. Note that 48kHz datastreams will need to be sample-rate converted first - then ever-popular Cool Edit has such a feature. Music Choice streams are, of course, already in the required 44.1kHz format. Music Choice plays CD tracks, and you would of course buy the original CDs - wouldn't you? In all, though, the home recordist has never had it so good! The potential for excellent sound quality is unlikely to be bettered.

But there's even more - how does the direct download of MP3 music to your hard disk sound? A service, known as r@dio.mp3, recently started up for the benefit of German cable customers. It broadcasts nothing but complete music tracks and jingles - a kind of DJ-free radio station along similar lines to Music Choice Europe. If you can understand German, more details can be found at **`http://www.musicplay.de.`** Basically, though, subscribers purchase a PC tuner card that plugs into their cable outlet, and run special software that decodes the transmissions and generates the MP3 files. The transmissions are sent to cable networks via satellite, and because they are not encrypted can be received by all! Well, theoretically at least - although the footprint of the satellite involved (Eutelsat Hotbird, at 13°E) covers the greater part of Europe, getting to those MP3 files is rather tricky and beyond the capabilities of the average domestic satellite viewer. Basically, they're transmitted in the teletext datastream of NBC Germany (11.057 GHz; horizontal polarity; symbol rate 27500; FEC 3/4). The flexibility of DVB2000, however, makes interception a reality. The first step is to get the teletext packet identifier (PID) so that the stream can be captured to the hard disk. One of DVB2000's menus gives you the audio PID, the video PID - and last, but not least, the teletext PID.

If you go to VGrabber and select the 'read from PID' menu, you can enter the PID value that was displayed by DVB2000. The datastream containing the MP3 files can then be captured to your hard disk as a binary file. Those captures can be as long as you like - they're ultimately restricted only by your hard disk's capacity. One more step is required before you can listen to the music, though - the raw datastream has to be processed so that the header information is removed. Some kind soul by the name of 'Michael R' has written the required program, and placed it on his web site **(`www.no-access.de`)**. It's easy and quick to use - simply specify the raw capture file, and it extracts all of the MP3 files - complete with ID3 tags - and dumps them in the directory of your choice. Judging by what I have heard, r@dio.mp3 is aimed at a very youthful audience. If yo don't like Euro-disco, you're not missing much! As one would expect, German-language pop music is also represented well. As with any radio station, you don't have any control over what's played. What more, at least one song is guaranteed to b incomplete because you can't hear the music and are thus always capturing 'blindly'. Note that obtaining music in this way is just as dubious as downloading MP versions of commercially-available recordings from an obscure FTP site - if n more so.

Martin Pipe welcomes comments and idea E-mail him as:
martin@webshop.demon.co.uk
Or look out for him online! His ICQ ID is: 15482544



```
Targetscan
ID 0: ----    ------          ID 0: IBM ... DM DVD2240E
ID 1: ----    ------          ID 1: ---
ID 2: ----    ------          ID 2: ---
ID 3: *DVB2000   Nokia rulez  ID 3: ---
ID 4: ----    ------          ID 4: ---
ID 5: ----    ------          ID 5: ---
ID 6: ----    ------          ID 6: ---
ID 7: ----    ------          ID 7: ---

ASPIStatus: 00000103 (OK)
Hosts found: 3
Mediamaster found at: Host: 0, ID: 3, Type: 9
DVB2000 Version: 2.14
```

```
1948
Polls:       109/301
Bytes read:  892928
Status:      Running
Bitrate:     198.90 KBps

☑ Direct write to File     Cut MCE-Songs to Files ☐
                           Skip first Song ☐
                           Use Title if possible ☐
Diff:   0
Songs:  0
Ref:

C:\audiotest.mpp
```

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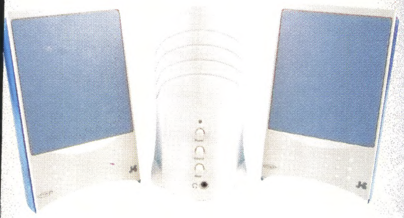

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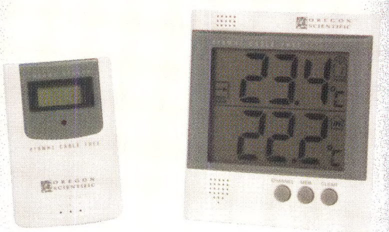

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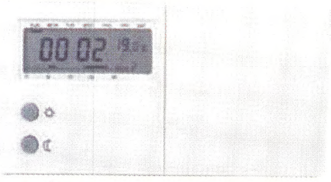

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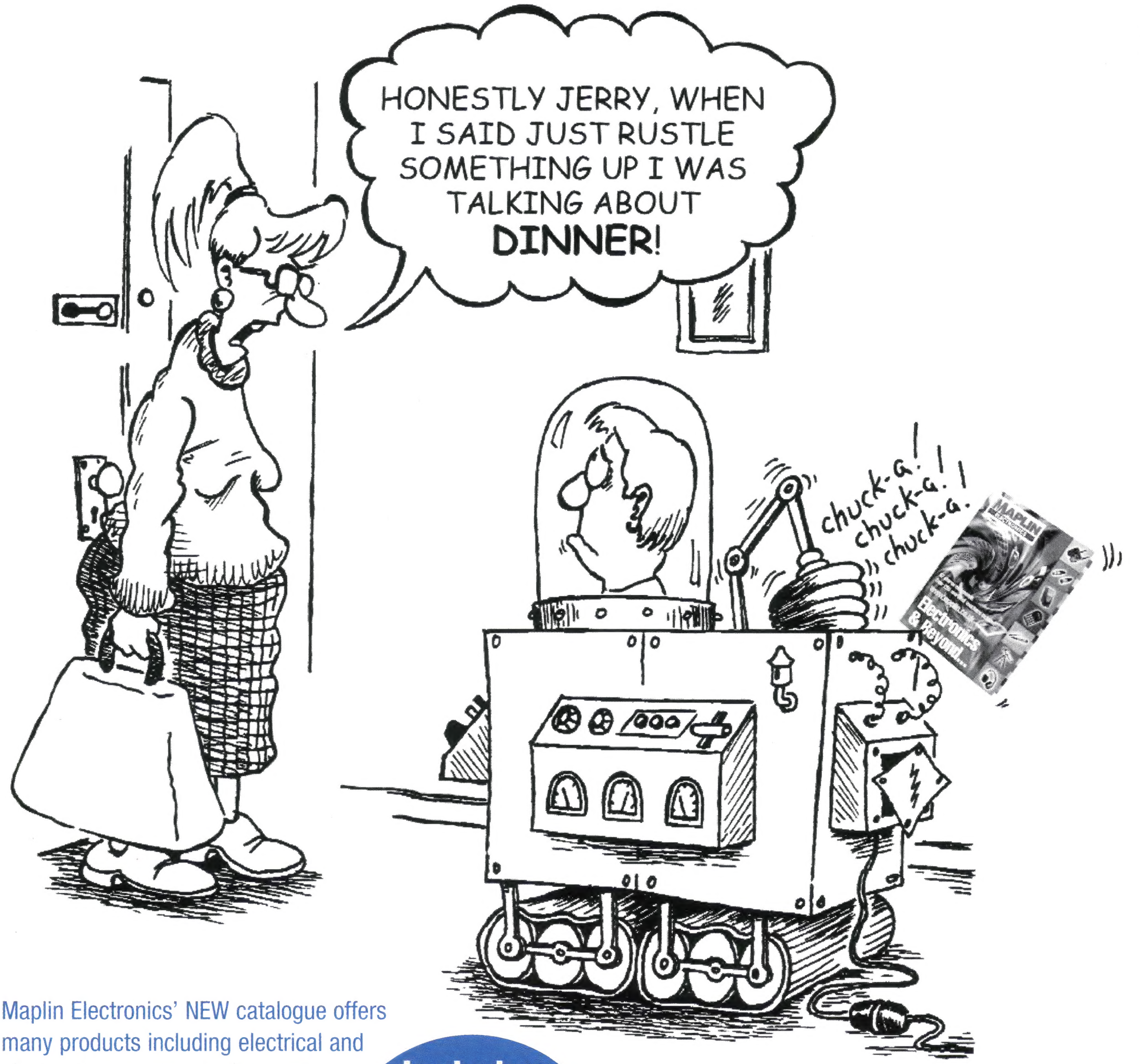
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